PARK SCIENCE
A RESOURCE MANAGEMENT BULLETIN

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PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1986

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

In This Issue

Cover Photo:
Whale #236 lunge feeding in the Lower West Arm of Glacier Bay (Story p. 3).

Editorial

"Against our will comes wisdom." Aeschylus

Ignorance can be casual, lazy, deliberate, or so close to knowledge as to be almost one and the same. It depends upon the individual or the organization that practices it.

Someone once compared the "I don't knows" of an Einstein with those of a loutish ignoramus. The oaf merely shrugs his shoulders over the simplest question and replies with an offhand "I don't know." An Einstein spends a lifetime of strenuous, inspired effort – learning everything his brains and intuition can tell him – and in the end whispers "I don't know." How can those two phrases be related?

The National Park Service, under the leadership of Director Mott, has opted strongly for the Einsteinian end of the "I don't know" range. In the January/February issue of *National Parks* magazine, Mott praises the Park Service's various recent efforts to broaden its knowledge of "the basic structure of plants and animals" and "of the world around us." He gives strong support to continued pursuit of such knowledge and the vastly improved management and interpretation of the National Park System that it makes possible.

The Director specifically cites Margery Oldfield's basic reference, *The Value of Conserving Genetic Resources* (published by the NPS in 1984), and the 1982 conference on Application of Genetics to the Management of Wild Populations of Genetic Resources (sponsored by NPS and MAB), out of which came Christine Schonewald-Cox's *Genetics and Conservation* – the first volume of a reference series.

Mott also mentions the ethnobiology study now underway at Great Smoky Mountains NP, aimed at producing the first computerized data base on cultural uses of the flora and fauna of a U.S. Biosphere Reserve. (*Park Science* story will appear in the Summer issue). He includes praise for the cooperation of the National Park Service with Man and the Biosphere, Florida State University, the University of Colorado, and Yale University in preparing an inventory and geographic information system of large protected natural areas of the U.S.

Then, for good measure, the new Director turns his attention to interpretation – the spreading of information (the "upgrading of ignorance") to the public, which pays for and uses our Park System.

"We need to expand the horizons of our interpretive message," he wrote in a recent *Courier*, ". . . the role of the parks as gene pools, as places where natural processes have preserved species of plants and animals in forms that may be forever altered elsewhere."

In specific backup to these inspiring statements, the Director has instructed the NPS science program to call a March workshop (see p. 18) on genetic diversity and to organize an "outreach committee" (see p. 23) to see that interpretation becomes heavily laced with knowledge about the Park System that science is disclosing and that management is acting upon.

These are strong and positive moves from a new leadership that is dedicated to pushing our resource management and our interpretation to the highest pinnacles of knowledge we can achieve before we have to stop and say "Here we stand. On this basis we will make our decisions."

When we have reached this platform, *then* we can pause and say, with pardonable pride in the high quality of our ignorance, "I don't know."

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Glacier Bay Research Supports Humpback Whale Management

By Anjanette Perry

Each summer, between 10 and 24 humpback whales *(Megaptera novaeangliae)* feed in the waters of Glacier Bay National Park, Alaska (Fig. 1). Historically, most of these whales remained in the bay and its inlets for the greater part of the summer. In 1978, however, 17 of the 20 whales abruptly departed the bay soon after their entry.

Two hypotheses were advanced: the first asserted that vessel traffic disturbed the whales and that the recent dramatic increase of vessel traffic had forced the whales to "abandon" the bay; the second proposed that the departure resulted from a natural decline in the availability of the whales' prey within Glacier Bay.

Concern for the welfare of this endangered species prompted the Park Service to consult with the National Marine Fisheries Service (NMFS). Following NMFS' recommendations in a 1979 Biological Opinion, the park published temporary regulations restricting the numbers of vessels entering the bay and prohibiting close approaches to the whales. In 1981 the park initiated a multidisciplinary study of humpback whales, their behavior, the distribution of their prey, and their acoustic environment.

Studies of humpback whale prey in Glacier Bay were carried out by Ken Krieger and Bruce Wing of the Auke Bay NMFS Laboratory, using a chart-recording fathometer. A fathometer introduces short pulses of high frequency sound into the water through a hydrophone or transducer; the echoes are then evaluated for timing and strength. The timing of the echo's return gives the depth of the "target"; the strength provides information about the size and density of the target. Target species are then confirmed using net tows. The use of fathometers or echosounders to detect and evaluate biological targets is generally referred to as "hydroacoustics," to distinguish it from bioacoustics or the study of biologically generated sounds.

Krieger and Wing found that the distributions, densities, and species compositions of whale forage varied considerably year to year. For example, a large school of capelin was present in Bartlett Cove in 1982, but no significant whale feed was present there in 1983, 1984, or 1985. Similarly, in 1984 schools of walleye pollack were concentrated in Sitakaday Narrows, where they had not been common before. In general, during the early 1980s Glacier Bay humpback whales fed primarily on schooling fishes found at discrete locations in the bay's lower reaches. In the 1970s, however, swarms of euphausiids in the mid and upper bay were speculated to be the main prey item. Since these swarms were not quantitatively assessed, it is not known whether prey densities were higher before 1978 than at present.

Glacier Bay's acoustic environment was surveyed by Paul Miles and Chuck Malme of Bolt, Beranek, and Newman, Inc. Using a calibrated hydrophone and tape recorder system, they collected radiant noise signatures of several cruise ships, tour boats, and smallcraft operating in the bay. The noise of individual vessels at a standardized speed of 10 knots varied considerably both within and across vessel classes. Generally, diesel-powered ships were about 10 dB noisier than steam-powered ships. Variations in smallcraft noise were a function of engine types, propeller conditions, and hull types. Long-term synoptic ambient noise levels were obtained using sonobuoys (buoys with attached hydrophones) set in mid-bay. Miles and Malme also investigated topographic sound "shadowing," in which features such as islands or peninsulas create zones of lower noise associated with a ship operating in the area. Such shadows do occur in Glacier Bay, and may reduce received noise levels by as much as 20dB.

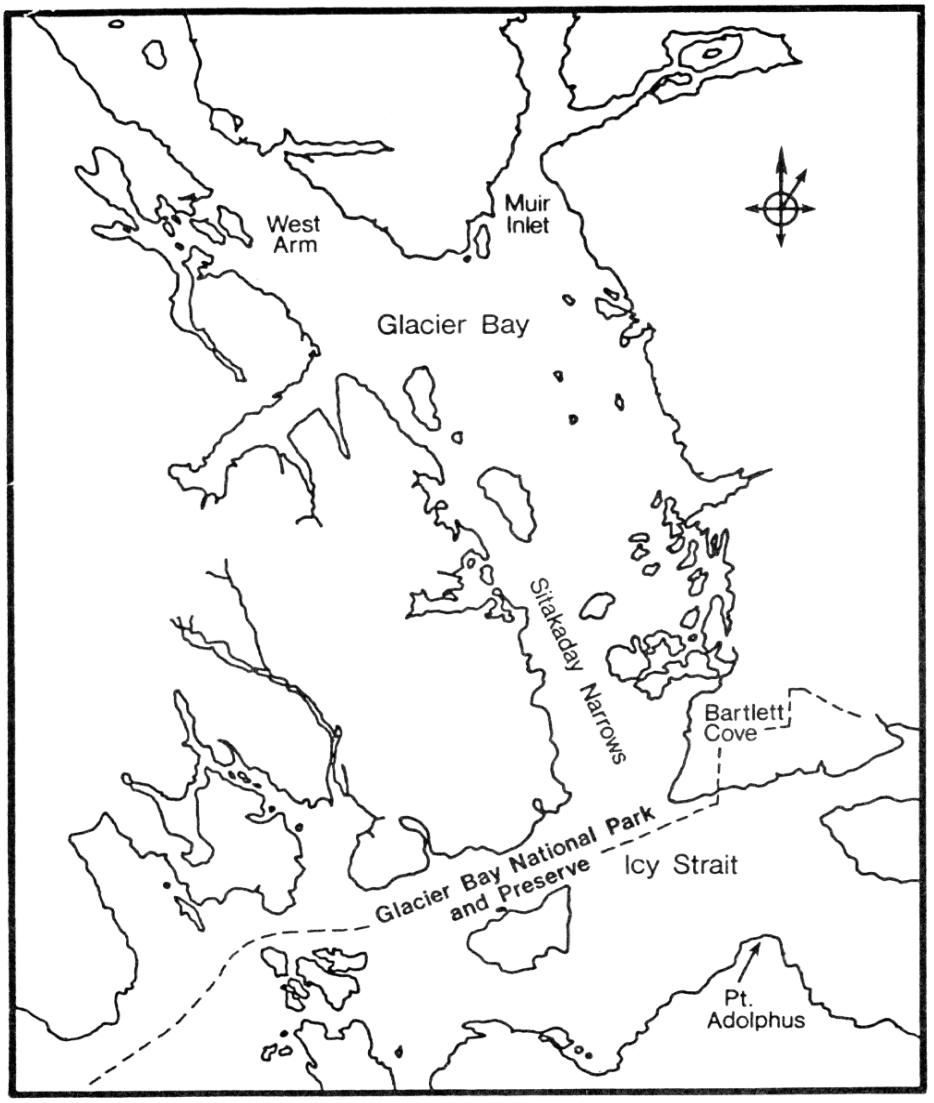

Figure 1. *Glacier Bay and adjacent waters.*

A team of researchers led by Louis Herman of the University of Hawaii (UH) conducted behavioral research. Scott Baker headed the field research until 1984, when the author served as field director. To observe whale behavior in the presence and absence of vessels, we set up shore-based observation posts at several locations around the bay. From these posts, positions of whales and of vessels relative to whales were measured with a high-precision surveyor's theodolite. Behaviors of whales were recorded on a microprocessor-aided time-event recorder. We also photographed whales from small boats for individual identification. The coloration, shape, and scarring pattern of the ventral surface of a whale's tail flukes are particularly useful for identification (Fig. 2).

The UH team demonstrated that loud vessel noise or erratic vessel movement can cause short-term disturbance of humpback whale feeding and social behavior. Two vessel avoidance strategies employed by the whales were described: (1) vertical avoidance if vessels were 0 to 2000 meters from the whale, and (2) horizontal avoidance if vessels were between 2000 to 4000 meters from the whale. Vertical avoidance involved increased dive times (though not necessarily to deeper depths), decreased respiration intervals, and decreased whale speeds. The horizontal avoidance strategy involved decreased dive times,

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Glacier Bay Research

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longer intervals between respirations, and greater speed of movement. Whales apparently moved into topographic shadows on a few occasions, although such movement was not statistically quantified. The presence of large ships was significantly correlated with aerial behaviors such as breaches and tail slaps. There was also close correlation between sudden changes in sound intensity and the onset of aerial behaviors. Many of the intensity changes resulted from variations in engine speed or propeller pitch.

The lack of comparable data prior to 1978 prohibited drawing the conclusion that either vessel traffic or changes in prey was solely responsible for the whales' exodus. However, in June of 1983 NMFS issued a second Biological Opinion which stated in part:

> We reiterate the conclusion in our 1979 Biological Opinion that if the amount of vessel use were allowed to increase without limit in Glacier Bay . . . the associated disturbance would be likely to jeopardize the continued existence of the Southeast Alaska humpback whale stock.

After reviewing the Biological Opinion, NPS established permanent regulations for protection of the humpback whale. These regulations limit the numbers and classes of vessels that can enter the bay during the summer months, establish vessel operating restrictions, provide a mechanism for designating whale waters (specially restricted areas) and vessel limits, and prohibit the harvest of certain species of fish and crustaceans that are prey species of the humpback whale.

Glacier Bay's Resource Manager, Gary Vequist, now hires a whale biologist each season. Scott Baker, who has held this position the first two seasons, employs many of the techniques and procedures he developed while conducting the behavior study. His present duties include monitoring the number of humpback whales that enter the park's waters, determining how long individual whales remain, and recording feeding and social behavior. Park Supt. Mike Tollefson will base future whale management decisions, such as changes in the number of cruise, tour, and private vessel entries, partly on continuing evaluation of the whale biologist's findings.

Ultimately, the management of humpback whales and their habitat will require solid understanding of the natural history of this endangered species. The observations and photographs by the University of Hawaii team and the whale biologist provided extensive data over the past four summers. Comparison of findings from the four summers of 1982 to 1985 describes both the across-season patterns and within-season variations of Glacier Bay humpback whale population dynamics. Additional historical information is available from the work of Charles Jurasz, a biologist who studied the whales in Glacier Bay during the 1970s. Reference to Jurasz's photographs and reports has provided up to 13 consecutive years of data on the life histories of some individual Glacier Bay whales.

Knowing the number of whales that enter the park each summer is of primary importance to their management. Over the past four seasons their abundance has fluctuated considerably. In 1982 and 1984 we identified photographically a total of 22 and 24 whales, respectively. In 1983 only 10 whales were identified. Three more whales briefly entered the bay that year, for a total of 13, but photographs of these were of too poor quality for individual identification. In 1985, 15 whales were present and individually identified over the summer. In all, 40 different whales were seen over the four years. Many of these whales had visited the park in previous seasons; 15 already were frequent park visitors in the early 1970s. Although most whales departed the bay in 1978, we know that at least these 15 did not leave permanently.

The duration of each whale's visit, known as its period of residency, was traditionally an important parameter for evaluating whale use in Glacier Bay. In recent years resident versus transient behavior has been complicated by the behavior of certain whales. These individuals have extended their range to include the waters near Pt. Adolphus, just outside the park, and they move in and out of park boundaries repeatedly during the summer. Therefore, at the end of each season the whale biologist prepares a diagram including the dates of all sightings of each whale, whether in the park or at Pt. Adolphus (Table 1). Resource Management makes use of these diagrams to track individual whales' movements, to determine their reproductive status (whether a whale has a calf in a given year), and to monitor overall use trends across years.

At about six months of age, a humpback whale is first brought by its mother to a feeding area such as Glacier Bay after completing the migration from southern calving grounds. Some of Glacier Bay's whales provide evidence that in later years the young animal returns to the same feeding region. One animal, nicknamed Garfunkle by Charles Jurasz, is the oldest whale known to have come to Glacier Bay as a calf. Garfunkle was first photographed in 1974, and has returned to the Glacier Bay area every year since. In 1985, two other animals first sighted as calves were documented returning to the bay. One was born in 1982, the other in 1984. Since 1982, tail fluke photographs of three more calves have been collected. Future studies will attend to the possible return of these calves.

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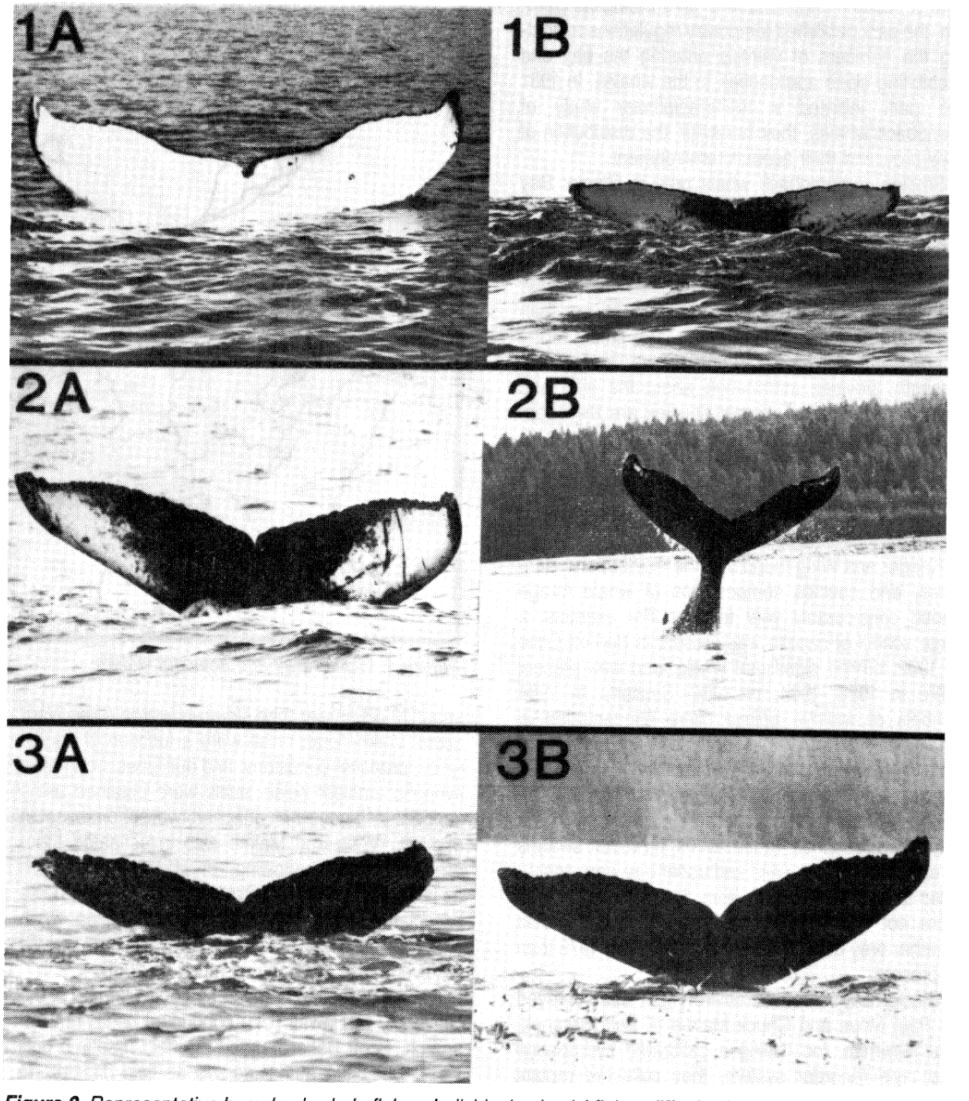

Figure 2. *Representative humpback whale flukes. Individual animals' flukes differ in shape, percentage of white pigmentation, and scarring patterns. Fluke photographs are categorized according to their proportion of pigmentation. Whales 1A and 1B are predominantly white (white extends across more than 50 percent of each fluke); 2A and 2B are moderately white (white covers less than 50 percent of each fluke; and 3A and 3B are dark (no white except for what appears to be scarring).*

Computer Corner

NPS "Common" Data Base

The WASO Natural Resources Divisions, in cooperation with other WASO program areas and the Information and Data Systems Division, is currently completing initial development of a Servicewide automated information base containing key information on each park unit. This Servicewide information management system, called COMMON, represents a "corporate data base" for the Service, and will allow NPS staff throughout the System to quickly retrieve and exchange key information on park resources, planning, operations, and administration.

The objective of COMMON is to provide an easily accessible source of key, summary-type information on the parks, covering a variety of different topics such as lands information, budget and visitation information, planning document information, administrative-type information, law enforcement information, and cultural and natural resources information.

In a typical "corporate data base" environment, users from many different organizations (parks, Regions, offices) **share** in the use of this "common" data, with each user organization contributing some of the data they generate or maintain into the common pool. In many cases, selected data from existing, program-specific data bases (such as the NPS lands data base or the NPS park directory data base) are directly "uploaded" into COMMON, on a recurring basis, thereby reducing actual data entry requirements and helping to ensure data accuracy and currency.

COMMON includes "basic" natural resources-related information including park siginificant resource features, significant resource problems or threats, status and availability of park baseline information, park ecological classifications, and management of areas adjacent to the park. The WASO Natural Resources Divisions will also be incorporating several additional "modules" into the overall COMMON system in the next six months.

Included are modules on park threatened, endangered and exotic species; park pest management problems and pesticide applications; park water rights information; park energy and minerals-related activities and threats; and a "Decision Tree" system, which will allow park users to identify the source of an observed pest problem and to receive treatment advice. In addition, the Servicewide NPFLORA data base soon will be incorporated into the COMMON system. At the same time, other WASO program areas, including Park Operations, Administrative Services, Cultural Resources, and Planning and Development, are contemplating the addition of "modules" to COMMON.

COMMON is currently running on the Service's Hewlett-Packard minicomputer system. COMMON is completely menu-driven and definitely "user-friendly." It can be accessed by anyone with a terminal, microcomputer, word processor, etc. with standard communications capability. Natural Resources and Information and Data Systems are planning to provide a series of workshops on COMMON early in 1986 to introduce the system for full field use and to get field suggestions on how to improve the system. User's manuals on the system should be ready for distribution to the field at the same time.

For more information, contact Anne Frondorf, WASO-Natural Resources, FTS: 343-8127 or Keith Carr, WASO-Information and Data Systems Division, FTS: 343-4463.

Glacier Bay Research

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Resighting these calves over the long term is of scientific interest for two reasons. When densities of schooling fish are high, whales frequently feed on them in cooperative "packs" of up to 10 animals. We suspect these social affiliations are composed of related whales. The resighting of females feeding with their offspring would support this hypothesis. Secondly, biologists judge the age of humpback whales by the number of growth rings in the ear plug. Without an independent means of calibrating this technique we don't know whether growth rings are formed yearly or semi-annually. The age of first reproduction occurs when 8-12 rings have formed, but it is unclear whether females are four to six years or eight to twelve years old at this time. The only Glacier Bay whale of known age old enough to have given birth is Garfunkle. After 11 years of sighting him/her unaccompanied by a calf, it seems likely, though not certain, that Garfunkle is a male. Although determining the age of first reproduction for female humpback whales could be a long process, the importance of this information justifies its research priority.

We photograph humpback whales throughout the year, both in southeastern Alaska and on the Hawaiian wintering grounds. Glacier Bay whales are frequently resighted. These data augment those collected during the summers, providing further insights into migration patterns, feeding ecology, and breeding biology. The NPS commitment to continuing the Glacier Bay work is allowing for increased understanding and improved management of this remarkable resource.

Perry is an oceanographer, currently working at the University of Hawaii under contract to the NPS.

Table 1.
Resight histories of whales photographed in the Glacier Bay – Point Adolphus region during 1984.

			July				August				September	
	Name	ID#	2	10	18	26	3	11	19	27	4	12
1.	Chop Suey	118	GGGGG	GGGGGGG					GGGG		G	G
2.	Gertrude	587	G	GG GG	G	G						
3.	Calf of 587	+	G	GG GG	G	G						
4.	Curly Fluke	566	G	G	G							
5.	Quits	535	GG GG									
6.	Calf of 535	349	GG GG									
7.		348	G	G								
8.	MD	157	GG A	A	GA	A			GA	A A		
9.		351	GG G G	GGGG					GG			
10.		350	GGG GG	G								
11.	Cow	573	A		A	AA		GGG				
12.	Calf of 573	382	A		A	AA		GGG				
13.	Dike	237	G G	AG								
14.		159	GGGA	GG		AA		G GGG		G		
15.	Spot	235	G	GG								
16.	Calf of 235	+	G	GG								
17.	White Eyes	117		GGG								
18.	Garfunkle	516		A		GGA		GG AA				
19.		381		G				G				
20.		387		A								
21.	Notchfin	232				G G		G				
22.		593				G G						
23.	Little Spot	236							GG G	GG		G
24.	Calf of 236	383							GG G	GG		G

KEY: G = Glacier Bay
A = Point Adolphus
+ = calves for which there is no fluke photograph do not have an ID #.

Plant Fossils Discovered in Badlands National Park

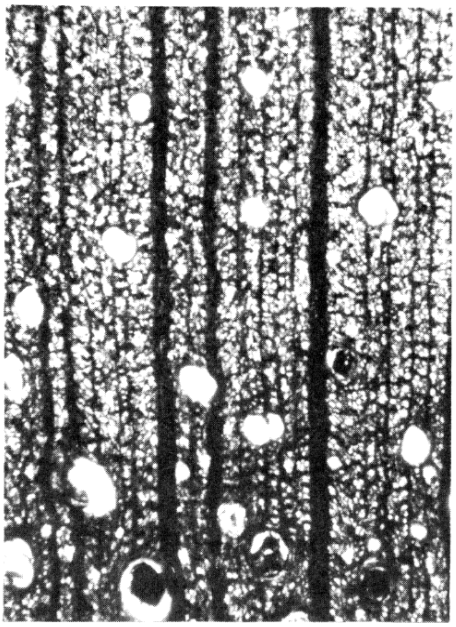
From near the contact *between the Scenic and Poleside members of the Brule Formation, an in situ fossil root with exceptionally well-preserved surface detail. This specimen has been left in place in the field.*

By Jay Shuler and Vincent Santucci

A uniquely rich Oligocene fauna was cited by Congress in the 1929 Act authorizing creation of a National Park unit in the White River Badlands of South Dakota. In taxonomy, the fossils range from snails to primates; in size, they vary from minute lizards to elephantine titanotheres; and in population and number of species, they may outrank the present day herds of the Serengeti.

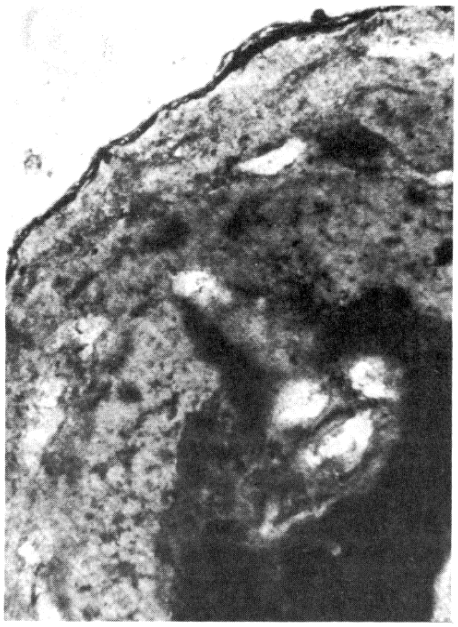
Paradoxically, except for widespread endocarps of hackberry, so few plant fossils have been reported from the White River formations that they have been little considered in constructing a view of the Oligocene environment here. Cleophas C. O'Harra in his classic *The White River Badlands* (1920) makes no mention of fossil plants, and John Clark, who to date has done field work in the Badlands for half a century, wrote in 1967 of "the absence of paleobotanical materials," and questioned the existence of fossil soils in these formations.

In a series of papers published between 1982 and 1985, Greg Retallack recognized root traces throughout these formations, and discerned 87 fossil soils. However, Retallack ventured no taxonomic conclusions about the traces, saying "vegetation has a very poor record in the Badlands."



Cross section of fossil wood *of a tropical tree resembling Diptocarpaceae. Members of this family are important timber trees in the Indo-Malayan region. This specimen came from the lowest level of the Chadron Formation.*

Closeup of the same specimen *showing tyloses (calluses or knobs). Roots and part of the stump were present when about 30 pieces were collected in the South Unit of Badlands NP in 1971 by Jim Legg of the Bureau of Indian Affairs and John Stockert of the park staff.*



At this point *in the study of these specimens, this appears to be a palm root. It is less well preserved than the wood of the tropical tree. Preservation varies by site and specimen.*

Plant Fossils Discovered

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The perception that the Badlands has a poor plant fossil record, compounded by the focus on vertebrate fossils, may have discouraged scientific search for plant fossils. Actually, it turns out that plant fossils are abundant in the Badlands Oligocene. In 1985 park personnel found fossil roots in situ (the first by seasonal interpreter Alan Scott), and petrified wood, at numerous sites in the field and also in the park museum collection. In thin section some specimens show cellular structure and original organic material.

Several of the thin sections look like fern, one like palm, and another like a tropical tree of the *Diptocarpaceae* (see photographs and captions for additional information). Collection continues. The study of these specimens by Dr. Wm. D. Tidwell of Brigham Young University will be published on its completion.

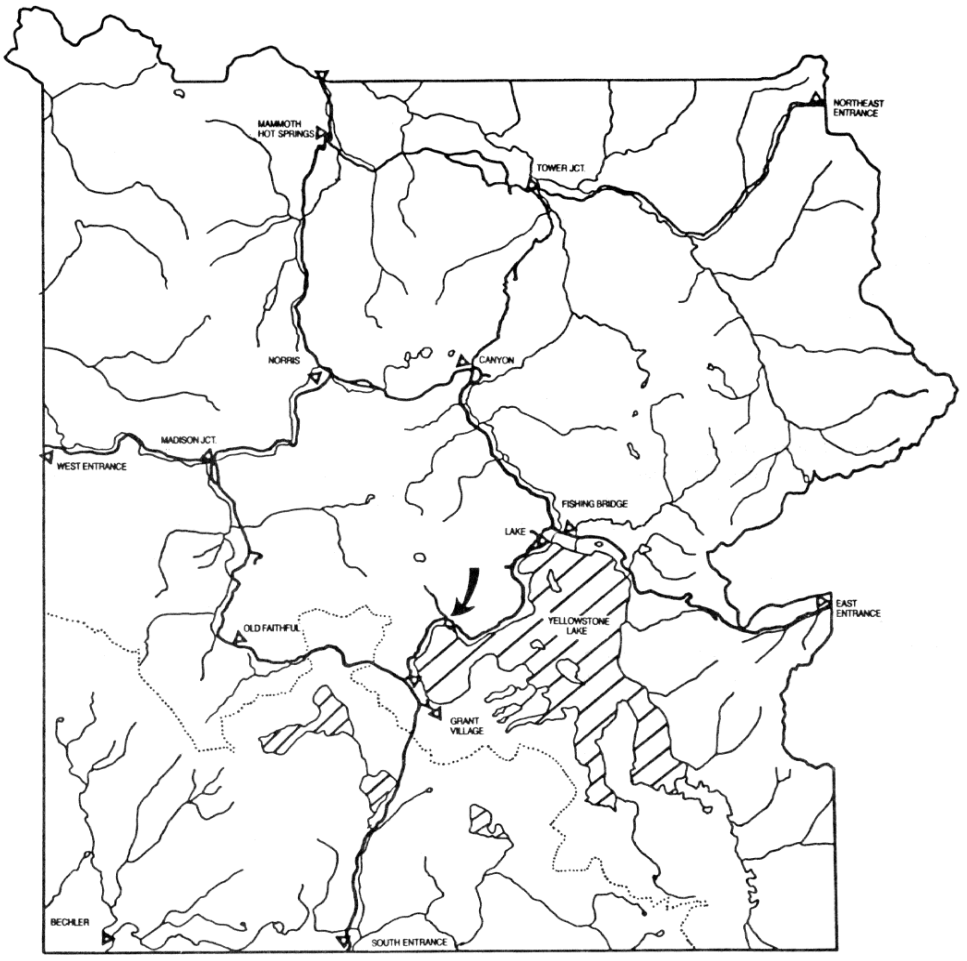
Discovery of these fossils suggests that additional research projects will be fruitful and that flora of the White River Formations will become better known.

Shuler is Assistant Chief Naturalist at Badlands National Park; Santucci is a seasonal naturalist and a graduate student in paleontology at the University of Pittsburgh.

***These structures** appear to be the vascular bundles of a fern. Another thin section, not illustrated here, shows what seems to be a leaf trace arising from a fern rhizome. Both the "palm" and the "ferns" were collected from the middle of the Scenic Member of the Brule Formation.*

Yellowstone Takes Action To Avert Ecological Crisis

By Sue Consolo



Yellowstone NP added an exciting chapter to its long and varied history in fisheries management when non-native brook trout were discovered (in Spring 1985) to have been planted in a major tributary of Yellowstone Lake, a stronghold of the cutthroat trout. To save the native fishery – a major recreational resource for visitors and food resource for endangered species such as the grizzly bear and the bald eagle – the park took quick, drastic measures. An entire creek drainage was poisoned to prevent the non-native fish from taking hold, and an aggressive public information effort resulted in favorable press coverage and surprisingly little controversy. Preliminary results indicate the eradication effort was successful, and it is hoped that an ecological crisis in the ecosystem has been averted.

Poisoning park waters may seem overly severe for a park which has had exotic fish species for nearly a century. Surveys and stocking of park waters first occurred in 1889, when the U.S. Army (administering Yellowstone) and U.S. Fish Commission introduced brook, rainbow, brown, and lake trout to barren lakes and streams. For the next 70 years, fisheries management consisted mostly of stocking and hatchery operations. In 1936, an enlightened policy established that non-native fish introductions would not be expanded or allowed in waters containing native fish; but all stocking did not cease until 1959. By that time, Yellowstone had 18 fish species, 6 of which were non-native. The exotic brown, rainbow, and brook trout are well-established and popular sport fish, especially in the western half of the park, in the Gibbon, Firehold, and Madison rivers.

The native trout are several subspecies of the cutthroat *(Salmo clarki)*, which has received high levels of angling pressure and attention. Yellowstone Lake and River survived those decades of intensive management without establishment of other trout species. Today, these waters in the eastern half of the park contain the last major population of the Yellowstone cutthroat, which attracts thousands of anglers and obervers to the late spring spawning runs. The lake and its trout also are a focal point for fish predators – eagles, ospreys, white pelicans, and grizzly bears.

A 3-5 person staff of U.S. Fish & Wildlife Service biologists is stationed in Yellowstone – full-time professionals and a seasonal crew who report to the Superintendent and are responsible for fisheries monitoring and management in the park. F&WS and NPS jointly fund this activity. In May of 1985 the F&WS staff were shocked to discover eastern brook trout *(Salvelinus fontinalis)* of several age classes in

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Yellowstone Acts

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Arnica Creek, which flows into the West Thumb of Yellowstone Lake. The creek is one of the lake's 140 tributaries; where the waters meet, a long spit of land forms a 58-acre shallow lagoon. Some time since sampling last occurred here 4 years ago, the brookies appeared. Biologists discounted the possibility that the trout could have migrated across the park from the Madison drainage. The park staff suspects a deliberate effort by a sportsman looking to introduce his favorite fish, an act which Supt. Bob Barbee called "an act of vandalism."

Brook trout, while much smaller than cutthroat, present a severe threat to the native species, successfully outcompeting cutthroats nearly everywhere they have been introduced. Brookies spawn in the fall; the next spring the newly-hatched fry have a size advantage over young cutthroat, which hatch in the summer. Brook trout can not replace spawning cutthroat, in size or timing, as a key spring-summer food source for grizzlies. Nor can they entirely replace the food resource for other piscivorous predators, nor the recreation resource for 300,000 visitors annually.

NPS and F&WS personnel acted immediately. They built a sandbag barrier across the lagoon to prevent trout movement out into Yellowstone Lake and other streams flowing into it. Adjacent tributaries were sampled, but no brook trout were found there or in the Arnica Creek lagoon. The resource management staff prepared an EA with 3 alternatives: 1) do nothing; 2) strengthen the lagoon barrier and electrofish, taking an estimated 5-10 years to achieve a 50 percent probability of success; and 3) eliminate all fish in Arnica Creek with a piscicide, Fintrol. The latter was selected as most cost-effective ($35,000) and timely. Treatment was set for late August in order to get the brook trout prior to spawning but during low water; this lessened the chance that fish would move between the creek and Yellowstone Lake. Dry summer weather simplified the task; only 10 miles of creek had water, instead of the 48 miles watered in wetter summers.

Prior to treatment, the park issued a park release offering $1000 reward for information leading to the conviction of the culprit who planted the brook trout. Such introductions have been illegal in Yellowstone for over 40 years. The park's public information office invited the press to come and watch the fish kill occur, and alerted fisheries biologists to stand by and answer questions if necessary. Park interpreters were stationed along the road near Arnica Creek to explain the situation to park visitors. As reporters and photographers gathered, resource managers nervously hoped the operation would go as planned!

Beginning at 6 a.m. on Aug. 27, 30 workers applied the toxicant Fintrol at 11 drip stations in Arnica Creek and springs up and down the drainage. Rangers and biologists boated back and forth across the lagoon, applying the poison. Personnel stood by with a neutralizer, in case the treatment escaped into the lake. Fintrol, a selective antibiotic that kills fish by inhibiting respiration, has a half-life of about 6 hours, and, at the applied concentrations of 4-8 parts per billion, will not kill other aquatic animals. Drip stations ran for 24 hours, but within the first 6 hours of application, the fish – mostly under 4" in size – began to succumb. No more than 100 lbs. of protein was estimated to have been removed from the drainage.

Monitoring activity continues. One week after the treatment, stream and lagoon sampling turned up no live fish. On Sept. 30, F&WS and NPS staff strengthened the sandbag barrier and placed a fish trap in the exit to the lagoon to collect any brookies trying to enter the creek to spawn. To assure total kill, a repeat application of Fintrol may be necessary.

The operation attracted national and local press, and surprisingly little controversy for a park accustomed to scrutiny of its planning and resource management actions. News articles and editorials were almost unanimously supportive. As both a biological and a public relations effort, it appears that the Arnica Creek fish eradication project was a success and that it occurred in time to prevent collapse in the food web in and around Yellowstone Lake.

Consolo is an NPS Resource Management Specialist trainee at Yellowstone NP.

information crossfile

"Ranking Wilderness Areas for Sensitivities and Risks to Air Pollution" is the title of a paper by J.P. Bennett, M.K. Esserlieu, and R.J. Olson, to be published by the USDA Forest Service. Using a sensitivity index that ranks the sum of the numbers of plant species in a wilderness area that are sensitive to SO_2 and O_3 and weighting these numbers by the relative abundance of each species, then coupling this ranking with actual ambient air quality data, the National Park Service has found that Saguaro National Monument, Great Smoky Mountains, Shenandoah, and Rocky Mountain NPs are experiencing the greatest risk of air pollution from SO_2 and O_3 together to vegetation of the 11 parks for which there are adequate data.

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The Washington NPS Office of Natural Resources reports availability of survey results from a recent study of *Giardia* and indicator bacteria in two popular, high-elevation watersheds in Rocky Mountain NP. The report, entitled "Field Survey of Giardia in Streams and Wildlife of the Glacier Gorge and Loch Vale Basins, Rocky Mountain NP," may be had by writing Karen Simpson, *Natural Resources Report Series*, Office of Natural Resources MS-470, NPS, P.O. Box 37127, Washington, DC 20013-7127.

Two additional reports available from this series are "Using Vegetation Biomonitors to Assess Air Pollution Injury in National Parks: Milkweed Survey," (a manual that park staff can use to evaluate conditions on milkweed plants that indicate presence or absence of air pollutants), and "Permit Application Guidance for New Air Pollution Sources," (providing guidance to persons intending to submit a Prevention of Significant Deterioration (PSD) permit application for a major source that has the potential to affect a Class I area.

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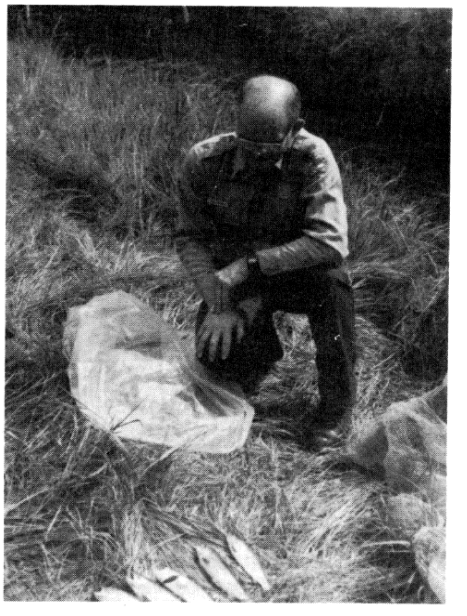
U.S. Fish and Wildlife Service biologists *set a fish trap in the Yellowstone Lake outlet of Arnica Creek.*



Asst. Chief Ranger Gary Brown *inspects alien brook trout removed from Arnica Creek.*

Tom Lucke reports that Vol. 12, No. 4, 1985 of the *Ecology Law Quarterly* contains "Morne Trois Pitons National Park in Dominica: A Case Study in Park Establishment in the Developing World" by R. Michael Wright (pp. 747-778). The article details the long and painful process leading to the establishment of a national park on the Caribbean island of Dominica. The author suggests that park creation in less developed countries most often takes place when the government is convinced that creating a national park is in its own best interests. Thus, the primary task for a park proponent is to highlight the benefits of park establishment and to show the particular government that these benefits outweigh any alternative uses of the park site and its resources.

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A 616-page, indexed, hard cover book, entitled *Hawai'i's Terrestrial Ecosystems Preservation and Management,* complete with full cover frontispiece, has been published by the Cooperative National Park Resources Studies Unit at the University of Hawaii. The volume, edited by Charles P. Stone and J. Michael Scott, is the proceedings of a symposium held June 5-6, 1984, at Hawai'i Volcanoes NP. (ISBN 0-8248-1048-1).

The volume will be reviewed in the Summer issue of *Park Science* by Dr. Sherwin Carlquist, professor of botany at Claremont Graduate School and Pomona College, Calif., and may be purchased for $22.50 from the University of Hawaii Press, 2840 Kolowalu, Honolulu, HI 96822.

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"The Parks as Genetic Islands," by Judith Freeman, appears in the January/February 1986 issue of *National Parks* magazine, with an overline stating "By the year 2000, 20 percent of extant species may be extinct. The parks may save us." Freeman's observation that parks may serve as genetic islands or *in situ* gene reserves, where healthy and diverse species populations could be maintained, is concurred with, in the same issue, by NPS Director William Penn Mott, Jr. His editorial, "Library of the Wild," calls the National Parks "a fragile treasure of species that can keep the planet alive and well."

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A review of *Bear Attacks: Their Causes and Avoidance,* by Stephen Herrero (Winchester Press, Piscataway, NJ. 1985. 287 pp. $14.95) by Katherine L. Jope, NPS Resource Management Specialist at Katmai National Park and Preserve, King Salmon, AK, appears in the January 1986 issue of the *Journal of Wildlife Management.* Jope forwarded a copy of the review to *Park Science*, calling the book "important, for the good of bears as well as people," and recommending it to "everyone who works in bear habitat." She also suggests that it should be made available to interested park visitors.

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Doug Wilcox, hydrologist at Indiana Dunes National Lakeshore is co-author of two journal articles that appeared recently. "New Records for Sphagnum in Indiana," with Richard E. Andrus of SUNY Binghamton, NY, in *The Michigan Botanist*, Vol. 24, 1985, expands the Indiana Sphagnum flora from 10 to 28 species and describes two unusual sites where these species are found – one an abandoned stone quarry near Greencastle, the other, Pinhook Bog in LaPorte County – an ice block depression in the Valparaiso Moraine, within the boundaries of Indiana Dunes NL. The second article is entitled "Cattail Invasion of Sedge Meadows Following Hydrologic Disturbance in the Cowles Box Wetland Complex, Indiana Dunes National Lakeshore;" appeared in *Wetlands*, Vol. 4, 1984 (but not until August 1985, Wilcox asserts).

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From John Aho at Olympic National Park comes word of a University of Washington doctoral dissertation by Richard Vong, "Simultaneous Observations of Rainwater and Aerosol Chemistry at a Remote Mid-Latitude Site," based on work performed in part within the park. Writes Aho:

"Olympic has been described as a 'clean' site in respect to atmospheric deposition. This study takes us one step further towards describing baseline, global levels of some chemical species, and understanding the marine contribution to the atmosphere. Further, the feasibility of using Olympic NP and Biosphere Reserve as a site for baseline monitoring has been assessed and some study parameters defined." Aho will provide a loan copy of the thesis for anyone interested.

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Thomas Lucke, Chief, Water Resources Division, Ft. Collins, reports the Vol. 12, No. 4 issue of *Coastal Zone Management Journal* contains an article entitled "A Systematic Method of Public Use Zoning of the Great Barrier Reef Marine Park, Australia" by K.D. Cocks, (pp. 359-383, 1984). The article reports on the application of a land-use planning method developed by the Commonwealth Scientific and Industrial Research Organization to the task of providing a zoning scheme for the Great Barrier Reef Marine Park. The approach also has been used by the Australian National Parks and Wildlife Service at Coorong National Park. Used in conjunction with geographic information systems and suited to development on a microcomputer, the methodology makes it possible to designate zoned areas (non-manipulative research areas, research areas, seasonal closure areas, development areas, etc.) in the ways that best meet various identified policy objectives.

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From Gary Larson in Corvallis, Ore., comes word of an article on Long-term Ecosystem Stress: The Effects of Years of Experimental Acidification on a Small Lake, by D.W. Schindler et al in *Science* 228:1395-1401.

This work, he says, demonstrates the complexity of ecosystem responses to external perturbations and that existing ideas and thoughts about such responses may be far less accurate than originally expected. The objective of the Schindler study was to determine the response of a lake ecosystem to artificial lowering of pH over an 8-year period. The pH was lowered from 6.8 (natural) to about 5.0, resulting in dramatic changes in phytoplankton species, cessation of fish reproduction, loss of some fish species, disappearance of the benthic crustaceans, reduction of the mean size of zooplankton, an epidemic of filamentous algae, and changes in the concentrations of calcium, magnesium, and aluminum. Some of the results were consistent with current beliefs about the impacts of acidification, but others were not. Expected declines of primary production, for example, and the decomposition of nutrients simply did not occur – suggesting that current thinking about the effects of acidification based on lab experiments may underestimate the resilience of natural ecosystems.

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The two latest views of the first U.S. national park are Richard Bartlett's *Yellowstone: A Wilderness Besieged*, (a 1985 produce of the University of Arizona press), and Alston Chase's *Playing God in Yellowstone: The Destruction of America's First National Park*, slated for March or April publication by Atlantic Monthly Press.

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Two articles of interest to fish scientists and managers, reported by Jim Larson from Seattle: "Conservation Genetics of Endangered Fish Populations in Arizona," which describes genetic findings and recommends conservation and restocking methods in Arizona based on the findings, in the July 26, 1985 issue of *Science*; and "Cascading Trophic Interactions and Lake Productivity," which looks into fish predation and herbivory as a means of regulating lake ecosystems, in the November 1985 issue of *BioScience.*

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"Deep ecology," a term coined by Norwegian philosopher Arne Naess in "The Shallow and the Deep, Long-Range Ecology Movement," in *Inquiry,* Vol. 16, 1973, pp. 95-100), has since spawned a growing body of literature. The latest entrants are two books, both entitled *Deep Ecology;* one by Bill Devall and George Sessions (Salt Lake City: Peregrine Smith Books, 1985) and one with Michael Tobias as editor (San Diego: Avant Books, 1984). According to Riley E. Dunlap of Washington State University's sociology department, the Devall and Sessions book is "clearly the most comprehensive treatment of deep ecology available."

Dunlap further cites journal literature on the subject: Warwick Fox's "Deep Ecology: A New Philosophy of Our Time?" in *Environmental Ethics* 6 (1984): 377-379; Ariel Kay Salleh's "Deeper Than Deep Ecology: The Eco-Feminist Connection, *Environmental Ethics* 6 (1984): 339-345; and Richard Sylvan's *A Critique of Deep Ecology,* Discussion Papers in Environmental Philosophy, No. 12, available free from the philosophy department, Australian National University, P.O. Box Box 4, Canberra, Australia 2600.

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An article entitled "National Park Management and Values," by Susan Power Bratton, appears in the Summer 1985 issue of *Environmental Ethics*, an interdisciplinary journal dedicated to the philosophical aspects of environmental problems and available from the University of Georgia's Department of Philosophy, Athens, GA 30602.

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SEAs Provide Ecosystem Focus For Management and Research

By J.T. Tunison, C.P. Stone and L.W. Cuddihy

Located in the southeastern portion of the most recently formed island in the Hawaiian chain, Hawai'i Volcanoes NP contains two of the most active volcanoes in the world, Mauna Loa and Kilauea. It also supports ecosystems of special importance in the study of evolutionary processes. Native groups such as lobeliads, the silversword alliance, honeycreepers and drosophila provide outstanding examples of adaptive radiation, endemism, genetic change over time, the biology of small populations, and the disharmonic results of colonization via long-distance dispersal.

The Natural Resources

A steep rainfall gradient (25 to 350 mm), a broad elevational range (sea level to 4,100 m) and variations in soil and topography account for a rich assemblage of living forms. Six major ecological zones are encompassed in the 87,940 ha of Hawai'i Volcanoes (Fig. 1). The *coastal lowlands* zone includes a number of vegetation types such as lowland mesic and dry forest, native scrub, pili grassland, grasslands dominated by exotic species, and coastal strand, and forms a band to 300 m elevation. The *submontane seasonal* zone includes such vegetation types as open 'ohi'a woodland, 'ohi'a/woodland scrub, 'ohi'a/native fern, and open lama forest. It is located from 300-900 m in elevation. The *montane rain forest* is largely tree fern or hapu'u/'ohi'a or 'ohi'a/tree fern and extends from 400 to 1,500 m. The *montane seasonal* zone contains mesic 'ohi'a/soapberry and mesic koa/'ohi'a/soapberry forest, koa parkland, native grasslands, and native shrublands, and is located between 1,000-2,000 m. The *subalpine* and vegetated portions of the *alpine* zones are characterized by native scrub dominated by a'ali'i and pukeawe. Recent lava flows and underground lava tubes represent additional important, but simpler, ecosystems.

The park contains current or potential habitat for seven and probably eight species of endangered birds, include the 'i'o, 'akepa, 'akiapola'au, Hawai'i creeper, o'u, nene, dark-rumped petrel, and Newell's shearwater, and habitat for one endangered bat. Native flowering plants number 248 species, (95 percent endemic, 43 of which are candidates for threatened or endangered status). Fifty-three additional species considered rare occur in the park.

The Threats

Hawai'i Volcanoes NP contains some of the least altered vegetation in the state; however, biological threats to native or near-native ecosystems from within the park and from adjacent lands are legion, and deterioration of park ecosystems continues.

Introduced ungulates have been especially disruptive. Feral goats have devastated much of the coastal lowlands zone in the past 200 years, depleting native species and favoring the spread of exotic plants. Although nearly eliminated from most of the park, goats still are present on adjacent lands and in the unfenced subalpine and alpine zones above 2,000 m. Feral pigs open up understory in wet and mesic forest to numerous alien plants and spread such invasive species as banana poka and strawberry guava. Control efforts in 57 km^2 of fenced pig habitat are succeeding, but this is only about 25 percent of feral pig habitat in the park. Other exotic animals include the black rat, feral cat, small Indian mongoose, house mouse, the Japanese white-eye (a bird), the yellowjacket wasp, and the night-biting mosquito.

Over 40 (of 475) introduced plants in the park are aggressive enough to threaten native ecosystems. In Hawai'i, non-native plants invade not only typical weedy habitats such as roadsides and man-made clearings, but also native or near-native plant communities. Besides directly displacing native plant species, non-native plants degrade native vegetation by changing fire, nutrient cycling, and water-soil regimes of Hawaiian ecosystems (Smith 1985).

The most serious exotic plant threats are firetree, banana poka, strawberry guava, kahili ginger, fountain grass, broomsedge and bush beardgrass, molasses grass, and kikuyu grass. Firetree invaded the park in the early 1960s and has spread over 12,200 ha of montane rainforest and submontane seasonal environments. Because of its nitrogen-fixing properties, even low densities may threaten native ecosystems by altering nutrient cycling in an area. Banana poka, an exotic vine capable of smothering native trees, increased 18-fold in the park from 1971 to 1981 (Warshauer et al. 1983). Strawberry guava and kahili ginger may form single species vegetation layers in rainforest and continue to spread even when feral pigs have been removed.

Fountain grass, broomsedge and bush beardgrass have spread dramatically in the last 25 years. Fountain grass occurs over 7,000 ha in the coastal lowlands and is spreading into upland plant communities, invading new lava flows and thus disrupting primary succession in some of the most intact systems in the park. Fire-adapted broomsedge and bush beardgrass have colonized openings in stands of native trees and shrubs in most of the submontane seasonal and much of the coastal lowlands. They have radically altered natural fire regimes by raising fuel loadings. Fires now are unnaturally intense, large, and frequent, and fire now favors non-native over native plants.

Approaches to Management, Research, and Interpretation

In Hawaiian systems, active management is often needed to protect and perpetuate ecosystems. Building a fence and abandoning an area may result in continued ecosystem degradation caused by invasive species. Native organisms on remote islands are notoriously vulnerable to invasive biota for several reasons. Because they evolved without them, natives are not adapted to diverse and/or severe stresses. For example, Hawaiian plants that developed in the absence of ungulates usually lack thorns, chemical defenses, sturdy stems, or adequate resprouting to survive ungulate foraging. Furthermore, populations of native species on islands are often present in localized and small populations, vulnerable to minor upsets in natality and mortality rates.

In addition, the close adaptation to stable local environmental conditions that occurs in tropical and subtropical areas can be severely affected by the ability of invaders to change microclimates or nutrient cycling. Finally, the effects of invaders are compounded by human disturbances to which island endemics are not adapted.

Parkwide control efforts currently are hampered by our lack of knowledge about the ecological roles of introduced species. Ubiquitous introduced birds (e.g. the Japanese white-eye and red-billed leiothrix); small mammals and invertebrates have been little studied. If we are to manage for natural processes, we need to know more about the roles of important alien animals in native and near-native systems.

A reasonable emphasis would seem to be more focus on management, research and interpretation in the most intact ecosystems remaining. Resources are not sufficient to restore ecosystems dominated by alien plants and animals. Nor is support adequate even to understand and interpret these areas. Present or anticipated funding cannot support the control of establishment and dispersal of such invasive plant species as fountaingrass and fire tree by conventional and chemical means throughout the park, let alone restore systems to near-native structure and processes.

Feral goat control in much of the park has been tremendously successful. However, removal of the exotic plant communities now present in former goat range in much of the park lowlands will probably have to await biocontrol (Gardner and Smith 1985) or considerable funding increases. Restoration also may require seeding and planting of native species in some areas. Feral pig control, expensive and long-term, is succeeding in nine management units, but is sometimes followed by considerable alien plant invasion. Areas chosen for feral pig elimination should have good restoration potential; the data base to choose areas amenable to both pig control and exosystem restoration is now accumulating.

Special Ecological Areas

Hawai'i Volcanoes NP recently has begun to emphasize Special Ecological Areas (SEAs), a strategy designed to protect, manage, understand, and interpret the most important biological sites in the park. SEAs are selected on the basis of representativeness or uniqueness of a vegetation type, intactness, species richness, presence of rare species, and potential for interpretation and research.

To date, six areas ranging in size from 12 to 2,700 ha have been selected and 12 additional areas nominated (Fig. 2; Table 1). Initial treatments of exotic plants have been completed in four of these areas and research and monitoring activities are underway or planned in others. Interpretation via one nature trail is ongoing, and other areas are routinely used for interpretation to individuals or small groups. Much more interpretation is needed. Some advantages of the SEA approach as we see them, are:

1. SEAs serve as a focus for control of introduced plants that cannot be controlled at present on a parkwide basis. Depending upon funding levels and characteristics of the species involved, buffer zones

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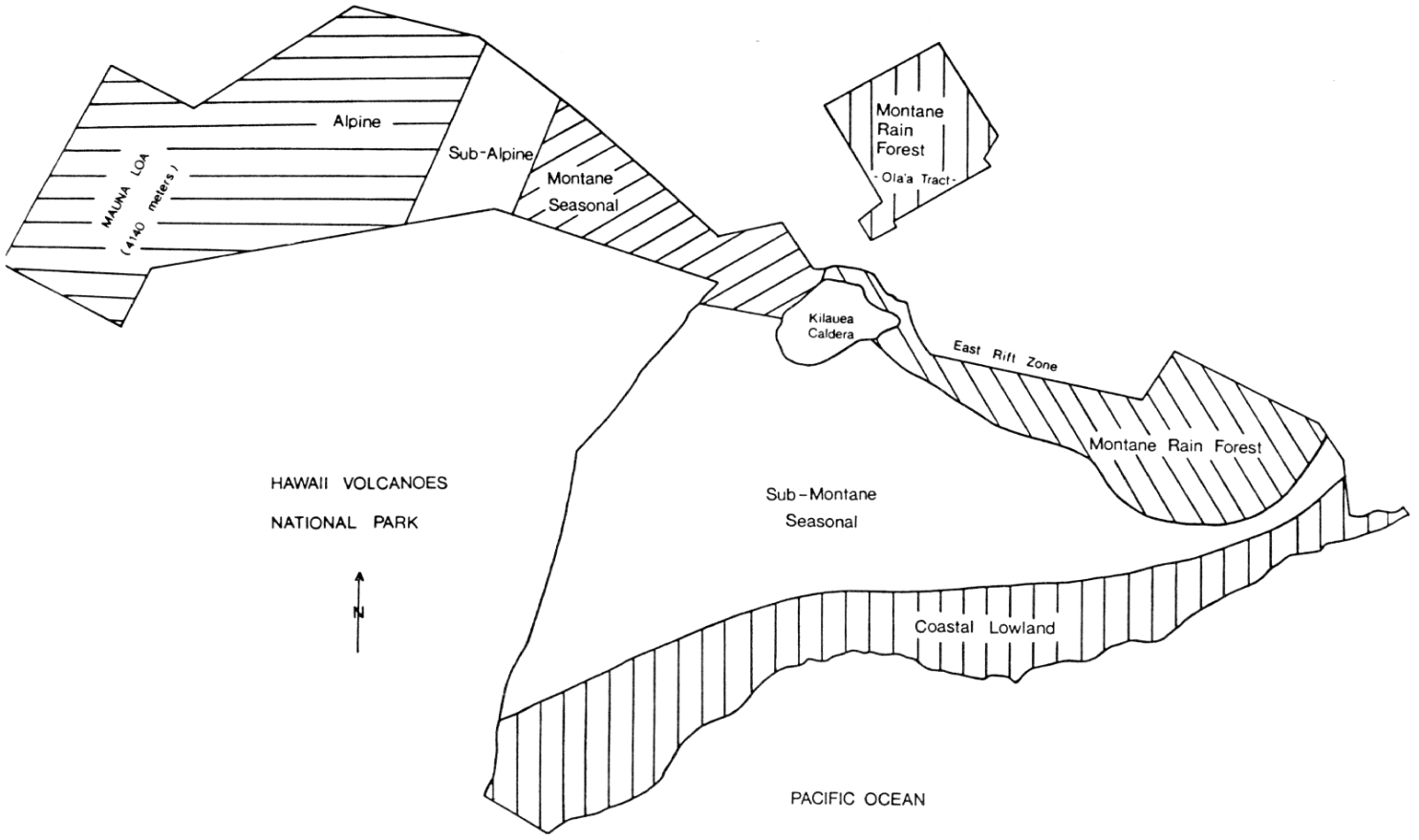

Fig. 1. *Ecological zones, Hawai'i Volcanoes National Park.*

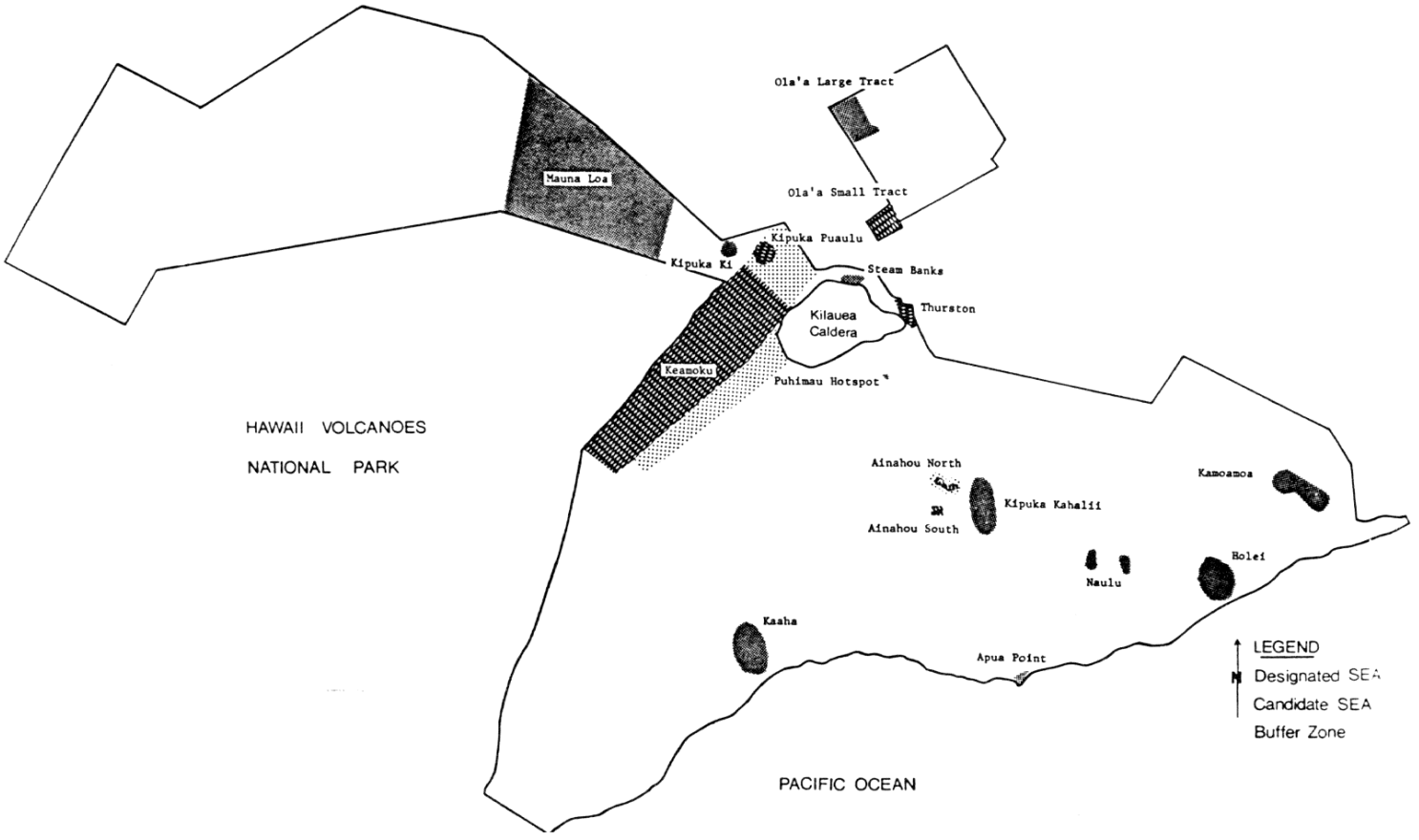

Fig. 2. *Locations of proposed Special Ecological Areas within Hawai'i Volcanoes National Park as of November 1985.*

SEAs Provide

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can be set up around SEAs to reduce dispersal of weeds that threaten them. Buffer zones may include neighboring ranches and forests, but for highly localized exotics, smaller zones may be sufficient. As funds become available, exotic plant control efforts can be expanded, but protection of the most intact systems is the primary focus.

2. Biological understandings can be gained through long-term monitoring and research in our most valuable representative and unique areas. Permanent plots, transects, weather stations, etc. can be established and data gathered over long periods in SEAs and in similar areas subject to less intensive management. What we learn from these key ecosystems can be applied to decisions about other parts of the park.

3. Interpretive activities too can be focused on distinct areas. In this way, the best biological systems can be shared with the public to promote understanding, appreciation, and funding. The public can be informed about the ongoing management and research efforts necessary to preserve the ecosystems they are viewing.

4. Feral ungulates are no longer present, have been present in minimal numbers for a long time, or are the focus of intensive control in SEAs. Thus, one of the most disruptive forces is minimized, and some healing of disturbed areas is under way.

5. Exotic plant control in SEAs is more feasible than in many parts of the park because of the dominance of native species. Exotic plants are localized and control therefore less difficult. Labor-intensive initial plant control often can be handled by volunteer groups. Park staff can provide low-level followup.

6. SEAs will serve as an increasingly important focus for recolonizations, plantings, and translocations of missing ecosystem components from elsewhere. For example, birds, plants, or invertebrates found in other more threatened ecosystems may sometimes be missing in SEAs. As ecosystems become more intact, natural processes, albeit under somewhat altered climatic and other man-influenced conditions should function insofar as possible. Self-sustaining systems should thus become more likely.

7. Restoration and control programs can be extended to more difficult areas outside SEAs as knowledge increases and funding becomes available. Some restoration projects may not ever be feasible, and use of less intensively managed buffer zones may be more realistic. However, native biota preserved in SEAs may be increasingly important in colonizing less intensively managed areas nearby.

It is possible that Special Ecological Areas may become islands of native organisms in a sea of exotics. However, we believe that considerable native biota will survive in many areas of the park outside SEAs, particularly if disturbance is minimized there through management. Hawai'i's native ecosystems are by no means a paradise lost, given adequate support and well-planned and active stewardship.

Valuable gene pools outside of SEAs cannot be abandoned and SEAs may be inadequate in size or number for indefinite perpetuation of processes such as succession, colonization, and evolution (Quinn et al. 1985). For example, many remote areas cannot receive the emphasis SEAs can, but are nonetheless vital for survival of native biota. Continued support for

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Table 1.
Ecological zone, vegetation type, and size of Special Ecological Areas to date in Hawai'i Volcanoes National Park.

Ecological Zone	Vegetation Type	SEA	Hectares
Coastal Lowland	Pili grassland	Holei	200
	Native scrub, lava, mesic forest	Kamoamoa	300
	Pili grassland	Ka'aha	200
	Strand	Apua Pt.	50
Submontane seasonal	Dry 'ohi'a woodland scrub	Ainahou North	12
	Dry 'ohi'a woodland	Ainahou South	33
	'Ohi'a scrub	Keamoku	2,700
	'Ohi'a scrub/woodland	Kipuka Kahali'i	150
	Dry lava forest	Naulu	50
	'Ohi'a/native fern	Steam banks	50
	Sparsely vegetated Thermal	Puhimau Hot Spot	6
Montane	Hapu'u/'ohi'a	'Ola'a (large tract)	283
Rain Forest	Hapu'u/'ohi'a	'Ola'a (small tract)	141
	'Ohi'a/hapu'u	Thurston	10
Montane	Mesic 'ohi'a/soapberry forest	Kipuka Puaulu	33
	(Buffer zone)		560
	Mesic koa/'ohi'a/soapberry forest	Kipuka Ki	50
	Mountain parkland	Mauna Loa	3,300
Subalpine	Native scrub	Mauna Loa	1,000
Alpine	Native scrub	Mauna Loa	1,000

A forest scene *on the edge of Naulu, at 50 ha, one of the smallest SEAs in Hawai'i Volcanoes. It was selected because it represents a relatively intact remnant of native lowland dry forest and contains several rare tree species such as the endemic lily, halepepe.*

IUCN Group To Explore Conservation Ethics

A three-day workshop on "Ethics, Culture, and Sustainable Development" has been scheduled for the World Conservation Strategy Conference meeting May 31-June 5 in Ottowa, Canada. Co-conveners of the workshop are Ron Engel, chairman of the IUCN Working Group on Ethics, Humanities, and the Arts, Commission on Education, and Peter Jacobs, Programme Chairman of the Conference.

The Working Group has been asked to write a new section for the World Conservation Strategy on the role of ethics and culture in conservation; its members have been invited to write brief papers on the subject, to be published as a "reader." Issues to be dealt with in the reader include: (1) why explicit concern for ethics and culture (including religion and the arts) is necessary for the success of world conservation; (2) critiques of the World Conservation Strategy – its principles and goals – from the standpoint of ethical and cultural concerns; (3) the contributions and limitations of traditional cultures to sustainable development, and new sources for viable ethics, and (4) specific initiatives in the area of ethics and culture that can promote the implementation of the World Conservation Strategy.

108 Park Units Listed in NPFLORA Data Base

The 1985 NPFLORA Status Report, prepared for the NPS Air Quality Division by Gary Waggoner and James Bennett, contains the flora of 108 park units, with Great Smoky Mountains NP leading the list – almost 1,500 taxa. Use of the data base has increased significantly to more than 190 queries annually, according to Bennett.

For 1986, 33 park units will be added to the data base and the entire base will be transferred to the HP 3000 in the Washington Office. The new tables added to the 1985 report give the most common trees and shrubs and the NPS coverage by acreage. It is now possible to provide a breakdown of the native versus introduced taxa of any park in NPFLORA.

Bennett asks for information about any contracts or projects in the works that may generate a species list for a park not yet in NPFLORA and encourages any park without a plant list to "get it done."

"The value of NPFLORA increases greatly the more parks that are in the data base," Bennett said, "no matter how small a park may be."

Many and Large, Large and Small: Nature Reserves Debate Goes On

By Peter White

In the Fall 1985 issue of *Park Science* (Vol. 6, Number 1), James Quinn and his colleagues described their ongoing research on island biogeography and the design of nature reserves. They concluded that several smaller reserves may sometimes be preferable to one large reserve of the same total area. Quinn and his colleagues were careful to point out the constraints that apply to their conclusions. In this article I will begin by enlarging upon those contraints. I do not intend this as a criticism of Quinn and his colleagues' work – I found that work interesting and admirable. Rather, my purpose is to put the issues in a larger context. Indeed, an overall conservation strategy for North America, one that will meet the variety of necessary conservation goals, must use both relatively large and relatively small reserves in a complementary scheme. Such a scheme is evolving at the present time through the often unrelated efforts of several national, state, and private agencies. However, we might also consider whether a more coordinated strategy is desirable or practical.

My comments derive in part from joint research that I have carried out with Susan Bratton, Ron Miller, and Jonathan Ambrose at the University of Georgia under a grant from the Man and the Biosphere Consortium. Although I will be emphasizing constaints to Quinn's conclusions, our own work on the southern Appalachian flora also showed that, **where the goal is maximizing species number at the outset of preserve establishment and where economic limits are set**, many small reserves may sometimes contain more species than one large reserve of the same area. However, that conclusion is predicated on the assumption that the purpose at hand is only to maximize species number in the short-term (in our case the number of rare plants) and that the species now present are capable of persisting after fragmentation of the overall landscape. The same constraints that apply to the article by Quinn and his colleagues also apply to our analysis (White et al, 1983). Some of these constraints are critical and are my subject here.

I must first review some aspects of island biogeography as they apply to preserve design. The theory of island biogeography was developed from studies of oceanic islands and avifaunas. By contrast, nature reserves are almost always "carved" out of larger blocks of land (e.g., Great Smoky Mountains NP within the southern Appalachian mountains). The species-area relationship for true islands is almost always steeper than the species-area relationship for comparably sized blocks of land demarcated within an intact continental landscape. Thus, it was predicted that when parks were "carved" out of this larger block of land and became isolated and island-like, they would suffer "faunal collapse;" that is, they would lose species to some new (and lower) equilibrium value.

Some of the work reported by Quinn and his colleagues' work treats, in a sense, the pre-faunal col-

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SEAs Provide

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attention to natural resources other than those in SEAs is critical.

One may argue that a program of parkwide management, research, and interpretation is the optimum strategy. However, this is not possible, because of funding constraints. Most of the progress in resources management in Hawai'i's parks has been made by dividing problems into manageable pieces and, with adequate support, attacking them in stages. We believe that such an approach also will lead to more effective management through better ecological understandings over short and long periods. Special Ecological Areas are an appropriate and timely step in that direction.

Tunison is NPS Resource Management Specialist at Hawai'i Volcanoes NP; Stone is an NPS Research Scientist; Cuddihy is an NPS Biological Technician.

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Max Peterson Awarded Wilderness "Silver Axe"

Max Peterson, Chief of the U.S. Forest Service, is the 1986 recipient of a special Wilderness Award, the Silver Axe, in recognition of outstanding leadership in the preservation of America's primitive skills heritage. Specifically, the award recognizes and commends Peterson's 1985 decision to deny the Environmental Protection Agency's request to use helicopters to retrieve water samples from nearly 500 wilderness lakes. Instead, Peterson had hundreds of Forest Service employees do the job, using primitive travel methods.

William A. Worf, retired Forest Service manager who began the recognition seven years ago, told Peterson: "Your decision kept the faith of the many dedicated Forest Service crews out there doing their level best to demonstrate that the Forest Service is the leading Wilderness Agency. No single action by Forest Service leadership in recent years has done more to bolster the morale or harden the resolve of field wilderness managers . . . Thanks!"

Many and Large...

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lapse problem. The controls on their experiments (demarcated "samples" within large contiguous patches, plus measurements before and after patch creation) become critical. As parks are established, the island biogeographical literature suggested that they would lose species as a function of their isolation and size. Taking two similar sized patches within a larger intact area and isolating one by affecting the surrounding land and leaving the other surrounded by "natural" lands as before, is one way to test "faunal collapse."

By contrast, Quinn's and his colleagues' work and ours in the southern Appalachians ask somewhat different questions: how can we contain the greatest number of species as a function of area acquired? Given a fragmented landscape, which will contain more species, two one-half-sized reserves or one full-sized reserve? In other words, Quinn and his colleagues questions, as interesting as they are, are not the only relevant questions to ask. To put this another way: island biogeography suggests an equilibrium number of species will develop within a given area, all else being equal. Species-area curves at one point in time may not reflect equilibrium; there may be important processes at work which will change the shape of those curves over time.

The four constraints that I summarize from Quinn's article are: (1) maximizing diversity is just one kind of conservation goal (actually, the island biogeographic literature treats one component of diversity only – **richness**, the number of species contained within an area); (2) that small islands may come to be dominated by weedy species (i.e., that design strategies select for which species are present, as well as how many species are present); (3) that different groups of species (mammals vs. birds) and species with different behaviors (migratory animals vs. relatively sessile animals) show different responses to given design strategies (i.e., the characteristics of one group should not be extrapolated for all groups); and (4) that target species like the larger birds and mammals require larger areas for population maintenance than 99 percent of the other species present (this is critical since these species may be important in food chains and in influencing the population size of other species).

Summarizing these constraints, if the goal of a conservation effort is to preserve a representative piece of a particular wilderness landscape (e.g., for the central Rocky Mountains, the southern Appalachians, the Olympic Peninsula), the one cannot readily accept the conclusion of the article by Quinn and his colleagues. In this situation, species number is not the only concern, and which species are present is important. The last item alone might be used to argue that all preserves that have as their goal the protection of wilderness ecosystems and their component species ought to be large enough to contain a minimum viable population (>500 individuals) of all of their large mammals. Given the track record of some existing National Parks, this argues for quite large parks ($>10^5 - 10^6$ ha). Quinn's article makes it clear that these constraints are understood; I want only to emphasize that the goal of the National Park System on a continental scale probably is more in harmony with the purposes stated at the beginning of this paragraph than the purpose of preserving species number alone.

Beyond the four constraints listed above, there are several additional concerns. The first two constraints below have to do with the processes responsible for the presence or absence of species within a given area when a preserve is "designed." These constraints suggest that area itself must be measured carefully – that drawing a line around populations at one point in time does not guarantee that you have contained all the necessary processes to maintain those populations in perpetuity.

(1) **Ecosystems are patchy in time and space.** As Pickett and Thompson (1978) discussed, natural disturbances (e.g., fire) may create landscapes which do not contain all seral stages – the preserve must be expanded to include the relevant area or will be vulnerable to particular natural events. Romme and Knight (1982) recently showed that the patch size of natural fire in Yellowstone National Park was large relative to a single watershed and that the Park itself (among the largest in the US) was barely large enough for a putative fire controlled equilibrium mosaic. In terms of static patchiness, it would be wrong to assume that the total area of a reserve is available to all species – there may be critically small habitat patches within even large reserves.

(2) **Species number within even large reserves may depend in part on lands beyond the reserve boundaries.** Most of our National Parks are contiguous with National Forest lands. Animals, even in large reserves, move in and out of the reserve. In other words, current parks may not be truly ecologically isolated; the species present within these parks in the short-term may not persist in the longer term if the reserve becomes island-like. They would thus require active management (reintroduction, prevention of extinction) – and I argue that the smaller the preserve, the greater the management effort necessary.

A third constraint has to do with threats to nature reserves:

(3) **Threats affect even the largest reserves.** This was Kushlan's (1979) point in a discussion of Everglades NP – that is a large park that nonetheless lost species due to water regime changes. Small reserves will depend on intensive management, whereas large reserves have a hope (albeit a faint one in the days of the spread of pollutants) of being self-maintaining wilderness.

My final constraint has to do with the definition of "large" and "small" sizes for reserves. We tend to debate strategies of "large" and "small" reserves without specifying spatial scale for particular circumstances.

(4) **The results of the article lack an absolute spatial dimension.** For example, 10 individual, non-contiguous, parks each one-tenth the size of Yellowstone might contain more species than Yellowstone itself (let us accept this for the sake of argument). But then 10 non-contiguous parks each one-tenth the size of these "smaller" parks (we are down now to parks one-hundredth the size of Yellowstone) would probably also contain more species than a single one-tenth-of-Yellowstone-park. Why? I believe these kinds of results are an artifact of how life's diversity is generally spread over the landscape. Contiguous areas are usually more alike in species content than non-contiguous areas.

To explain this last point, let us go to a very broad scale. If the goal of a particular conservation effort was to preserve the mammal fauna of the North American continent, then 10 reserves each the size of Yellowstone NP and spread out over the continent might be better (have more species) than one reserve equal to 10 times the area of Yellowstone and centered over that National Park – spread out over the continent, the parks would include more geographic areas, environments, and habitats. Thus, many "small" parks is better than one "large" park of the same total size. But in this case our "small" parks are indeed quite large. And the problem doesn't stop there – a system of 10 reserves each 10 times the size of Yellowstone would be better than one reserve 100 times the size of Yellowstone.

I doubt the chain of relativity can be broken for any particular landscape. That is, I believe the conclusions of Quinn and his colleagues cannot be used to specify a particular preserve size or subdivision strategy, unless some limitation is first imposed. They can be used if a conservation goal is first stated (e.g., preserving the flora of a county in California, or of the whole state, or of the nation) and if economic limits are imposed (e.g., the amount of land that can be acquired is pre-set). Under these circumstances, one could evaluate the one-large versus several-smaller preserve strategies. If the goal and economic resources are varied, then the optimum strategy varies. The National Park Service's goals, as I understand them, tend to be whole-system and continental in scope. Before carrying out design based on subdivision (because of limited financial resources), it might be desirable to find the political will to accomplish a larger conservation purpose (e.g., instead of creating 10, one-tenth-sized, reserves for a total size of 10^4 ha, find the resources to create 10 full-sized reserves at a total size of 10^5 ha).

To list some simple lessons from our existing large National Parks: Yellowstone is barely large enough for a predictable outplay of its fire regime and too small for its large grazers and predators to be influenced by Park Service policy only. Everglades, while the largest National Park in the East is too small to contain its own hydrologic regime and has seen declining populations as a result. Great Smoky Mountains NP has lost its large predators and is influenced by the spread of exotic species, flooding by a man-made reservoir, and air pollutants from beyond park borders.

The island biogeographical literature usually gives us two preserve variables (size and number) and thus four choices: few-small, few-large, many-small, and many-large. The first is not discussed since it represents biological folly. The best strategy from a strict conservationist's view point (many and large parks) is omitted from most articles such as mine and that of Quinn and his colleagues only out of deference to political reality. Although the literature has tended to produce polarized debate over the remaining choices (many-small vs. few-large), could it be that both can be important?

An ideal conservation strategy at the continental scale might include many large parks set aside for the goal of maintaining wilderness ecosystems. Such parks would be large enough to support self-sustaining populations of all large mammals and birds (I single these taxa out because they tend to have the largest home ranges) and would be large enough to contain the natural dynamic mosaics of seral states

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research notes

Human Impact Monitoring

In the summer of 1985 the Northwest Alaska Areas (NWA) began a human impact monitoring program. Even here, with over 8 million acres of land, a small local population, and low numbers of visitors, the impact of humans can be seen. The project objectives were: 1) to document, monitor, and mitigate human impacts, 2) to assess the levels of human use which cause measurable impacts in various habitat types; and, 3) to measure recovery times of soils and vegetation once impacted.

The NWA parklands, which consist of Noatak National Preserve, Kobuk Valley National Park and Cape Krusenstern National Monument, are located 40 miles north of the Arctic Circle in the western Brooks Range. Dominant plant communities are arctic tundra, boreal spruce forest and coastal lowland. Three types of human-caused disturbances have become apparent in the parklands: regularly used campsites (including ranger stations), airplane landing strips on tundra, and snowmachine/ATV trails. Seven sites representative of these uses were identified for intensive monitoring. Several other sites were photo documented, only.

The variables identified as the most important in determining the degree of impact sustained were: the season in which the impact occurred, pattern and intensity of use, type of vegetation, soil moisture, depth to permafrost, slope, aspect and soil density. Herbaceous cover was measured using point intercepts along a line transect and by quadrat sampling with application of the Daubenmire cover classes. Shrub cover was determined by the line intercept method. Due to the variation in vegetation types no single sampling technique was chosen. Rather, combinations of several methods were used. Sorensen's similarity index provided a means of quantitatively comparing vegetation on disturbed and reference plots.

Human impact monitoring is a long-term project. As part of our written progress report, recommendations were made to management on minimizing site impacts. We have not set criteria for determining when a backcountry site must be closed to use, user limits, etc. – limits which are already in place at many other parks. Input from resource managers who have been involved with this sort of research or who have incorporated backcountry user limits into management guidelines, would be appreciated. Our research progress report is available to interested individuals.

For more information contact Kate Roney or Lee Anne Ayres, Northwest Alaska Areas, Box 287, Kotzebue, Alaska 99752.

Wilderness Task Force Seeks Uniform Policies

By Karen Simpson

NPS Director William Penn Mott, Jr. recently appointed a Wilderness Task Force to review wilderness management policy and develop a wilderness program. At the Tucson Regional Directors' meeting in November, 1985 it was proposed that the NPS develop a wilderness action program in support of the Director's 12-Point Plan.

The Task Force met on January 14-16, 1986. At the Director's suggestion, the Task Force used the Five-Year Management Action Program developed by the Steering Committee of the First National Wilderness Management Workshop convened by the University of Idaho as a basis from which to develop its report.

The Task Force recommended that the policies contained in the 1978 *Management Policies* manual concerning wilderness management should not be changed substantively. The group found them consistent with the intent of the Wilderness Act of 1964 and adequate as general policies.

However, the members of the Task Force noted that wilderness areas are not managed consistently Servicewide. Reasons for this include (1) superintendents interpret wilderness policy differently, (2) the NPS does not coordinate wilderness policy centrally, (3) the NPS has not published guidelines on issues such as the use of aircraft in wilderness areas, and (4) the NPS does not have an efficient way to collect and disseminate information to the parks about wilderness management techniques.

The Task Force discussed the elements of an action plan that would deal with these issues and improve NPS wilderness management generally. Participants considered the recommendations of the Steering Committee of the Wilderness Management Workshop for inclusion in the action plan, and agreed that most of the Steering Committee's recommendations should be included. The Task Force suggested other items to be included in the plan, for example, that the Director designate a wilderness coordinator in WASO and establish an NPS Wilderness Coordinating Group. The coordinator could collect and disseminate to park managers information on wilderness management techniques, analyze the uses that visitors and others make of wilderness areas to ensure that they are appropriate, inventory wilderness training needs, and use consumer advertising to educate the public on wilderness management issues. The Coordinating Group would work with other Federal land managing agencies on wilderness management planning, training and research activities.

The participants also suggested ways in which park managers could improve wilderness management. For example, they could prepare wilderness management plans, as part of their RMPs or separately, identify threats to wilderness, set limits of acceptable change for wilderness resources, and determine the minimum requirements their parks have for mechanized and motorized equipment in wilderness areas. Park managers also could conduct workshops and other programs relating to wilderness management, provide the public with more information on wilderness management and expand interpretive activities relating to wilderness.

The Task Force is currently preparing its recommendations on wilderness management policy and the five-year wilderness action plan and will distribute these recommendations to the Regional offices for review and comment shortly.

Simpson is a program analyst in the WASO air quality division.

Many and Large...

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caused by the outplay of natural disturbances like fire. Let us call this park goal #1. Such a goal is national in scope and such preserves would be $>10^4$ ha in extent. There should be a minimum of 5 of these "goal #1 parks" in each biogeographic province.

Next, there should be a system of smaller areas (10^1 to 10^3 ha) that have the purpose of protecting additional species within the biogeographic provinces and valuable natural resources (including old-growth forests, geologic features, unusual habitat types). Such private groups as the Nature Conservancy are already working along these lines. Thus, the ideal conservation strategy would always include many reserves; relatively large and relatively small reserves might both have a function in this strategy.

White is leader of the NPS/CPSU at the University of Tennessee in Knoxville.

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"Policy Capture' Technique

In *"Predicting the Effect of Altenative Trail Design on Visitor Satisfaction in Park Settings,"* Joanne M. Westphal and Stanley R. Lieber discuss the results of a technique called "policy capture" to establish optimum trail prescriptions in a highly urbanized forest environment. Central to the discussion are projected trade-offs in visitor use and satisfaction with specific trail designs and locations. The article appears in **Landscape Journal**, Spring 1986 (Vol. 5 No. 1); the Cook County Forest Preserve (Chicago, Ill.) serves as the study site.

regional highlights

Mid-Atlantic Region

The Region recently sponsored a training course titled "Introduction to Natural Resource Monitoring." Held at Shenandoah NP, the five days of sessions (in both classroom and field) were designed to teach basic resource monitoring skills, data gathering techniques, and the set up and conduct of resource inventories. Topics included small mammal surveys and the monitoring of campsite inventory and impact assessment, air and water quality, fire effects, wildlife telemetry, immobilization, and populations, IPM and pests, and campsite inventory and impact assessment.

* * *

The New River Gorge National River is sponsoring the 1986 New River Symposium on April 10-12, Wytheville, Va. Papers will be presented on cultural, historic, biological and geological resources. (See Meetings of Interest).

* * *

Shenandoah NP is sponsoring a 50th Anniversary Symposium on May 8-9 at the park's Skyland Lodge. Purpose is for scientists, resource managers, and the public to share research results and discuss current resource issues. (See Meetings of Interest.)

Midwest Region

The Midwest Regional Office is cooperating with the University of Nebraska-Lincoln in the development and implementation of a prairie monitoring procedure for 11 parks in the Region. Most of these are small-acreage parks where prairie vegetation forms a significant part of the historic scene. The program is being designed to measure the effectiveness of current and future management actions, such as mowing, burning, and herbicide use, in meeting park specific restoration/management goals. Regional Office and university personnel expect to be able to train a number of park resource managers in the procedure this September.

North Atlantic Region

The Park Service successfully terminated New York City's operation of the Fountain Avenue Landfill within Gateway NRA as of Dec. 31, 1985. Studies by our Rutgers CRU are now being formulated to ensure that adequate final closure is carried out to protect the Jamaica Bay ecosystem and to allow safe recreational use of the site. This site will provide Gateway with long-term revenues from a methane gas extraction project being conducted jointly with the City.

* * *

A report entitled "Geomorphic Analysis, Fire Island Inlet to Montauk Point, Long Island, NY" and edited by S.P. Leatherman and J.R. Allen has been completed. This comprehensive synthesis of field studies, funded by the Corps of Engineers, New York District, was conducted over the past six years through NARO. The 375-page study presents details of the geophysical interpretation, morphologic analysis, quantitative shoreline and environmental change,

Continued next page

***Fish sampling techniques** are taught Mid-Atlantic Region trainees by Biological Technician Jim Dexter at a training course for natural resource monitoring.*

Volunteer Botanists Create Herbarium For Whiskeytown

By Ray C. Foust

Editor's Note: Ray C. Foust, Superintendent of the Whiskeytown Unit, Whiskeytown-Shasta-Trinity NRA in California, sent Park Science *the following article, expressing his "extreme pleasure" with the results of the project and suggesting that this kind of cooperation would be of interest to resource managers all over the System. We think it deserves notice on the Regional Highlights page.*

The Shasta Chapter of the California Native Plant Society, through a volunteer project for the National Park Service, has provided the Whiskeytown Unit with its first baseline data on the area's plants. A total of 91.5 volunteer hours were spent collecting, pressing, identifying, labeling, mounting, and cataloging approximately 400 species to create an herbarium.

The project was spearheaded by David Biek, head of Technical Services at the Shasta County Library and author of *Mushrooms of Northern California.* An amateur bontanist, Biek has put in more than 60 hours of volunteer time. He was attracted because of his strong desire to find new plants. "Most of these are plants I've never seen before. In fact, some of these *families* I've never seen before!" said Biek.

The project's most significant result, aside from creation of the herbarium, is the discovery that Whiskeytown has an unusually rich flora for an area of only 42,500 acres, probably due to the variety of habitats found in the Unit. An elevation range of 800 feet to 6,209 feet, the number of year-round and intermittent streams, the blending of species from both the Klamath and Sierra Nevada mountain ranges, and human disturbance of the area each plays a role in providing variety. As the project continues, Biek expects to find another 100 to 200 species, particularly grasses, high elevation plants, more orchids, and a variety of oaks.

David Biek, educated amateur.

Some of the surprises from this survey include the discovery of the exotic species tamarisk along Clear Creek, the discovery of *Boykinia major* a saxifrage previously known to grow only in the coastal redwood forest, and a dozen different species of *Cortinarias* mushrooms in one locale.

This project has truly been a success story for the Volunteers in the Parks program. The Whiskeytown Unit has been able to obtain a plant collection for reference by its staff and has established some baseline vegetation data at virtually no cost. At the same time, a local citizen has had an opportunity to use his expertise in a creative, constructive manner, earning him tremendous satisfaction and the support of fellow amateur botanists.

Regional Highlights

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geochronology, sedimentology, and stratigraphy of this barrier island/upland coast, and includes a review of expected impacts from proposed Corps of Engineers erosion control and hurricane protection schemes.

The Long Island barrier chain does not follow the "rollover" model, but is dominated by inlets – with a longshore spit extension forcing a westward migration of historically permanent Fire Island Inlet on the western end of the chain and the breaching by storms at 50- to 75-year intervals on the eastern end, as well as the intervening inlets providing bayside sedimentation for the barrier substrate. Thus, the west is axially stable but narrowing, while the east is rapidly transgressive with wide marshes and a migration rate of one island width in the last 300 years. The subaerial portion of the barrier chain is comprised of a thin, but locally complex, veneer of aeolian sands overlying a continuous overwash wedge.

As a result of these studies, Fire Island NS is now the subject of one of the most detailed geomorphic data banks on barrier islands in the world.

* * *

In September 1985, Hurricane Gloria, with winds up to 90 mph, swept over Fire Island NS. The effect of this disturbance on the Sunken Forest – a maritime forest community – will be studied this summer by Dr. Henry Art of Williams College, Massachusetts.

Alaska Region

Regional Chief Scientist Al Lovaas reports recent publication of two research projects conducted in Denali National Park: "The Controlled Traffic System and Associated Wildlife Response in Denali National Park," by Francis J. Singer and Joan B. Beattie, *Arctic*, March 1986 issue, and "The Denali Ungulate-Predator System," by Francis J. Singer and John Dalle-Molle, *Alces* 21 (1985). For reprints, contact Lovaas.

* * *

Limited numbers of two new Research/Resource Management Reports are available through the Regional Office: "Forest Habits and Range Conditions of Bison and Sumpatric Ungulates on the Upper Chitina River, Wrangell-St. Elias NP and Preserve" and "Land Use in the North Additions of Denali NP and Preserve: An Historical Perspective." The former is by Dale Miquelle; the latter, by William Schneider, Dianne Gudget-Holmes, and John Dalle-Molle, identifies and describes current park subsistence uses and processes governing resource allocations in the area and describes locations in the additions that are of past significance to local people.

* * *

Layne Adams, Research Wildlife Biologist, and Alan "Eli" Eliason, Resource Management Specialist, joined the Regional Office in the past year. Eli came to Alaska in November from a two-year NPS assignment in Saudi Arabia, and Layne, formerly with BLM in Fairbanks, arrived in March 1985.

Water Resources Division

WRD Report No. 86-4, "The Armoring Process on the Fall River," describes armoring on a dynamic stretch of the Fall River in Rocky Mountain NP and compares two models that predict stream bed armoring. The report is available from the Division, 301 S. Howes St., Room 343, Fort Collins, CO 80521.

* * *

A Water Resources project for the Chesapeake and Ohio Canal NHS, a closely coordinated effort of the NPS Water Resources Division, the park, and the National Capital Region, has reached the draft scope of work stage. The two main objectives are (1) to reduce accidental drowning in the vicinity of Great Falls by establishing a warning system that will alert park personnel to imminent hazardous conditions; and (2) to provide the park with the hydrologic information and tools to minimize flood damage to facilities and historic structures and protect park visitors during floods. The proposed warning system for Great Falls will be a state-of-the-art ALERT (Automated Local Evaluation in Real Time) system.

Western Region

Channel Islands NP recently initiated a broad-based natural resources monitoring program to assess ecosystem health, discover abnormalities in system structure and function, define limits of natural variation, and test hypothesis of cause-and-effect among system components. A modified "Delphi" technique was used to select index species for population dynamics monitoring. An ecological systems analysis is being used to evaluate the Delphi design and to integrate the monitoring program. It will also be used to develop hypotheses about system dynamics.

The first phase of systems analysis was begun in 1985. In December, two 2-day workshops held at park headquarters in Ventura, Calif., began development of a conceptual ecological model of the park. The workshops also introduced 11 members of the park staff and 10 local scientists to a systems approach developed by Prof. Bernard C. Patten, University of Georgia, and adapted to Channel Islands NP by his research group. Working with Dr. Patten and his team, Drs. Mia Tegner, Scripps Institute of Oceanography, James Kremer and Richard Zimmerman, University of Southern California, Charles Cooper, San Diego State University and David Parker, California Department of Fish & Game, developed a framework for marine ecosystem models in the park and produced a 100 compartment provisional kelp forest model.

In a second workshop, Paul Collins, Santa Barbara Museum of Natural History, Steve Junak, Santa Barbara Botanic Garden, Ronnie Fowler, University of California Santa Barbara (UCSB), Mark Sogge, U.C. Davis, Lyndal Laughrin, UCSB Santa Cruz Island, developed a framework for island ecosystem models, produced provisional models of grasslands and sea cliffs on San Miguel Island, and began construction of adjacency matrices describing component interactions for those models.

The workshops were organized by Gary Davis and William Halvorson, NPS research scientists assigned to Channel Islands NP.

* * *

On Jan. 27-28, 1986 more than 80 scientists, educators and technicians gathered at the Ash Mountain headquarters of Sequoia NP to review progress and discuss future priorities for the acid precipitation/air pollution research program underway in the park. Presentations were made on such topics as the transport of pollutants, concentrations of particulates and gasses in the atmosphere, the sensitivity of aquatic, soil and plant communities to pollutants, and the use of remote sensing to detect the health of forest ecosystems. The meeting documented the occurrence of man-caused pollutants as well as the existence of highly sensitive ecosystems. Areas of additional research needs that could help predict the nature and extent of such potential impacts were discussed.

The meeting was followed by a workshop of NPS site coordinators for those parks involved in long-term acid deposition research. The workshop, jointly organized by Bill Gregg (WASO acid deposition coordinator), David Graber and David Parsons (SEKI research scientists) provided a forum for program review and comparison. Research protocols and future priorities also were reviewed. Participants included Bob Stottlemyer (Mich. Tech and ISRO), Jill Baron (Water Resources and ROMO), John Aho (OLYM), Bob Edmonds (U. Wash.), Tom Stohlgren (SEKI), Rick Webb (U. Virginia and SHEN), John Melack (U. Calif. Santa Barbara), and Kathy Tonnessen (Calif. Air Resources Board).

The research program, which represents one of the largest of its kind in the western United States, is a joint effort of such groups as NPS, the State of California Air Resources Board, the USGS, the USFS, NASA and several universities and private utility interests. Investigators represent over a dozen separate universities as well as federal and state agencies. The program is expected to last at least through 1991, which represents the scheduled end of the National Acid Precipitation Assessment Program, the Congressionally mandated study of sources, transport and potential impacts from acid precipitation.

Southwest Region

Two papers were presented by Padre Island National Seashore personnel at the Minerals Management Service's annual information exchange meeting in New Orleans in October, 1985. Park Biologist Bob King presented one on the beach trash problem in general (his research results to date) and Chief Ranger Max Hancock presented a paper dealing with the 55-gallon drum problem (see article elsewhere). As a result of these presentations Great Ideas Productions, Inc. Lacombe, La., were contracted by Conoco, Inc., New Orleans, for the Offshore Operators Committee to produce an educational video tape entitled "All Washed Up" for employees involved in offshore oil and gas operations. Great Ideas theme is the experiences of an offshore employee's family vacationing on the national seashore beach. We don't want to spoil the punch line but expect something like "Hey, Dad, isn't this the hard hat you lost last week?"

Another film, entitled "Cleaning Up," provides an excellent overview of the hazardous waste problem in America. The film is available on loan or for purchase in 16mm, 1/2" and 3/4" VHF from: The Chemical Manufacturing Association, 2501 M Street N.W., Washington, D.C. 20037 (202) 887-1100.

* * *

Oryx Update: An aerial reconnaissance of White Sands National Monument the weekend of Feb. 8 revealed at least 44 Oryx within the park boundary. Although efforts were made to herd them out of the

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Scientists Identify, Evaluate Indicators To Monitor Wilderness Conditions

By Linda Merigliano and Ed Krumpe

Wilderness managers face a difficult challenge: how to protect an area's natural ecological conditions and, at the same time, provide opportunities for visitors to enjoy a wilderness experience (Wilderness Act PL 88-577). Human use inevitably causes some change in wilderness conditions; therefore, managers now seek ways to detect unacceptable changes in environmental and experiential conditions. The 1985 Fall issue of *Park Science* highlights two new approaches being developed to help managers meet this challenge: the Forest Service "Limits of Acceptable Change" system and the National Park Service "Visitor Impact Management" system. Common to both these approaches are monitoring indicators, which are defined as specific elements of the wilderness setting that change in response to human impacts (adapted from Stankey et. al. 1984).

Current interest in monitoring indicators also comes from legal mandates such as amendments to NEPA (PL 91-190), which call for "the development and use of indices and monitoring systems." However, managers cannot afford to monitor every aspect of the park or wilderness environment; thus, they will need to select a limited number of indicators. To date there has been little information available to help managers select the indicators that have a proven ability to detect changes in soil, water, air, vegetation, wildlife and recreation experiential conditions. As Wall and Wright (1977) concluded:

> The most appropriate measures of environmental impact have yet to be determined. Assimilation of the knowledge from various fields will be difficult unless researchers from different disciplines work together (p. 50).

Last year the University of Idaho Wilderness Research Center began a study to identify and evaluate indicators that could be used to monitor human-caused change in wilderness conditions. Hundreds of indicators *could* be monitored: thus, this exploratory study sought to determine which indicators offered potential to warrant further field testing.

Table 1
Criteria Used to Identify and Evaluate Indicators

Long-term significance	– The indicator detects a change in conditions which cannot be reversed in five seasons with reasonable management effort.
Short-term significance	– The indicator detects a change in conditions which occurs within one season.
Responsive	– The indicator detects a change in conditions which is potentially responsive to management control.
Detects amount	– The indicator detects the amount of change in conditions.
Sensitive to wildness	– The indicator detects a reduction in the area's ability to provide a wilderness experience (defined as a primitive and unconfined type of recreation having outstanding opportunities for solitude).
Feasible	– The indicator can be measured by field personnel using simple equipment and sampling techniques.
Reliable	– With training, different observers will collect the same information.
Correlates with human use	– The indicator detects a change in conditions which can be correlated with a specific type of human use.
Economical	– The indicator produces information of acceptable accuracy which is worth the expense of measurement.

Through a series of three questionnaires, a panel of 100 biological, physical and social scientists, who had conducted research in wilderness and National Parks, were asked to identify and evaluate indicators. Nine criteria were developed from a prior literature review to provide a common basis for the scientists to identify and evaluate potential indicators. These criteria are listed in Table 1.

The panel identified more than 200 indicators that could be used to monitor wilderness conditions. These preliminary indicators then were organized under three basic wilderness components: BIOLOGICAL (vegetation and wildlife/fish), PHYSICAL (soil, water, and air) and HUMAN (visitor population description and experience). Each panel member then selected the 20 preliminary indicators they felt best met the criteria.

In the final questionnaire, each of the 32 most frequently selected indicators was evaluated by the panel to determine whether or not the indicator met each of the nine criteria. The top three ranking indicators for various components of the wilderness environment are presented in the preliminary results displayed in Table 2. Further literature review of

Continued on next page

Table 2
Indicators Evaluated Highest by Scientists to Monitor Wilderness Conditions

BIOLOGICAL	PHYSICAL	HUMAN
Vegetation	**Soil**	**Visitor Population Description**
• Number and distribution of campsites per area • Percent of ground cover loss on campsites • Range condition and trend in grazed meadows	• Firering density (number/area) • Percent or area of exposed mineral soil on campsites • Number of multiple trails in meadows or wet areas	• Number of groups per area, trail or river per day • Distribution of visitor use over week or season • Number of pack animals per trail per day
Wildlife/Fish	**Water**	**Experience**
• Abundance of selected wildlife/fish spp. sensitive to human presence • Population trend of selected wildlife/fish spp. sensitive to human presence • Distribution of selected wildlife /fish spp. sensitive to human presence	• Fecal coliform count • Fecal coliform/fecal streptococci ratio • Mean concentration of selected nutrients in water (e.g. nitrates, sulfates, phospates)	• Number of other groups encountered while at campsite • Quantity and distribution of litter (human garbage) • Number of other groups encountered on trails or rivers per day
	Air	
	• Air visibility • Ambient concentration of selected chemicals in air (e.g. SO_2, NO_2, O_3)	

Based on the cumulative score for each indicator on the nine criteria

indicators will supplement information collected from the panel of scientists. At the completion of this study we will report the ranking of all 200 indicators. In addition, we will report how each of the top 32 indicators was scored on the nine criteria (see Table 2).

Results of this study have revealed that the identification and evaluation of indicators to monitor wilderness conditions is an extremely complex topic. Given the current state of knowledge, managers will need to monitor many indicators to cover all wilderness components. Only when the relationship between indicators and their ability to detect change in wilderness conditions is better understood, can the number of indicators monitored be significantly reduced.

However, this study has developed criteria to evaluate indicators and has identified the indicators that seem to offer the most potential to monitor wilderness conditions. The stage is now set for further research to develop appropriate measurement techniques and set up long-term monitoring programs to field test potential indicators in various ecosystems.

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Wall G. and C. Wright. 1977. The environmental impact of outdoor recreation. Dept. Geol. Publ. Series No 11. Univ. of Waterloo, Canada.

Merigliano is a graduate assistant at the University of Idaho. Krumpe is Director of the Wilderness Research Center at the University of Idaho, Moscow, ID 83843.

Regional Highlights

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monument with a helicopter, these efforts were unsuccessful. Oryx, as you may remember, are the largest of the African antelope and may weigh up to 600 pounds. Strategies now being considered are the use of spring-loaded gates and the judicious use of electric fences.

Pacific Northwest

A research boathouse, installed on Wizard Island last summer, has made possible the first ever attempt to sample Crater Lake water quality in winter. The Crater Lake NP winter research team has trained in winter survival and will be expected to remain on the island five days at a time, after being helicoptered in. If weather conditions push helicopter use beyond nine days, the team is prepared to climb out of the caldera on the snow. Tasks include deploying one research boat, collecting samples at various depths and sites around the lake, and completing analysis as possible.

There was a young man from the Lake
Who felt he had all he could take.
He said "There's too much snow."
But where else could he go
And have a yard he didn't have to rake?

A "Poor Jarvis" original
from Crater Lake NP

GIS Project On For Alaska NPs

By Gary Ahlstrand

A project is underway to develop a geographic information system (GIS) for each park unit in the Alaska Region of the National Park Service (NPS). Landsat thematic mapper (TM) data and Defense Mapping Agency (DMA) digital terrain data are being used to derive landcover and fuel classes for these areas, which account for more than 54 million acres in the National Park System. The project is a cooperative effort between personnel of the Service's Geographic Information System Field Unit (GISFU, Denver) and the Alaska Regional Office (ARO, Anchorage).

A subjective reconnaissance level ground sampling program began in the parks during the summer of 1984 and will continue this summer (1986). Ground sampling teams document information on vegetation, fuels, and topography while site locations are marked on Alaska High Altitude Program (AHAP) color infrared photographs (approximately 1:60,000 scale) and United States Geological Survey topographic quadrangles (1:63,360 scale).

Twelve TM digital data tapes of imagery covering all or portions of Gates of the Arctic NP and Preserve, Kobuk Valley NP, Noatak National Preserve, Cape Krusenstern National Monument, Bering Land Bridge National Preserve, and Wrangell-St. Elias NP and Preserve have been purchased from the Earth Observation Satellite Observation Company. The scenes were acquired between July 7 and Aug. 8, 1985. The remaining scenes will be purchased as acceptable tapes become available. The digital data are being processed and analyzed using Earth Resources Laboratory Software (ELAS). Field data and AHAP color infra-red photograph signatures are correlated with initial multispectral classes to determine if lumping or additional refinement is needed to derive meaningful landcover classes.

Digital terrain data (1:250,000 scale) from DMA tapes were converted from arc-second to planar format for use with ELAS. Slope (19 increments), aspect (9 classes), elevation (100 foot intervals), and mean slope length files were created for all parks from the reformatted DMA tapes.

Until now the analysis of these digital data has been done using the GISFU's ancient Varian computer. Through a joint procurement effort, the GISFU and ARO are each in the process of acquiring a color graphics workstation (micro supercomputer) with a UNIX operating system, and peripheral hardware. The ARO is loaning its new system to the Earth Resources Laboratory, National Space Technologies Laboratory, National Aeronautics and Space Administration for up to one year for use while making a number of refinements to ELAS and converting it to run under a UNIX-based operating system.

Additional themes will be added to each GIS in response to the needs of individual parks and as resource information becomes available. The full potential of this tool will be realized only when it is put into the hands of field managers so that they may display, manipulate, update, manage, analyze, and plot the mapped data for use in making better informed resource management decisions. Our goal is to put GIS's on computers in each NPS area of the Alaska Region.

Ahlstrand is a Research Ecologist with the NPS Alaska Region.

meetings of interest

1986

April 10-12, THE 1986 NEW RIVER SYMPOSIUM, at Wytheville, VA. Contact, William Cox at New River Gorge (304/465/0508) for agenda and accommodations information.

May 1-3, INDIANA DUNES RESEARCH CONFERENCE, Indiana University-Northwest, Gary, IN. Contact, Ron Hiebert, Indiana Dunes National Lakeshore, 1100 N. Mineral Springs Road, Porter, IN 46304.

May 8-9, THE SHENANDOAH NP 50th ANNIVERSARY SYMPOSIUM, at the park's Skyland Lodge. Contact, Dave Haskell at the park (703/999-2243) for agenda and accommodations information.

May 12-16, FIRST NATIONAL SYMPOSIUM ON SOCIAL SCIENCE IN RESOURCE MANAGEMENT, Oregon State University, Corvallis. Contact, Donald R. Field, NPS/CPSU, OSU 97331.

May 22-23, 12th ANNUAL MEETING ON SCIENTIFIC RESEARCH, THE S.E. REGION'S UPLAND SECTION, at Great Smoky Mt. NP headquarters; no registration fee.

June 10-12, SYMPOSIUM ON CONTROL OF INTRODUCED PLANTS IN HAWAII'S NATIVE ECOSYSTEMS, at Hawaii Volcanoes National Park. Contact Charles P. Stone, park research scientist, HI 96718, or (808) 967-8211.

June 13, HAWAII VOLCANOES NP NATURAL SCIENCE CONFERENCE, at Hawaii Volcanoes NP. Contact Charles P. Stone (see above).

June 22-26, TENTH BIENNIAL NORTH AMERICAN PRAIRIE CONFERENCE, at Texas Women's University, Denton, TX. Contact Native Prairie Assn. of Texas, TWU, P.O. Box 22675, Denton, TX 76204.

July 13-20, CONFERENCE ON RESEARCH IN THE NATIONAL PARKS, NPS and George Wright Society co-sponsors, at Col. State U, Fort Collins. Contact, Ray Herrmann or Calvin Cummings, 339 Aylesworth Hall NW, CSU, Fort Collins, CO 80523.

Oct. 21-24, THIRTEENTH ANNUAL NATURAL AREAS CONFERENCE, at Trout Lodge Conference Center, YMCA of the Ozarks near Potosi, MO. For information write Natural Areas Conference, P.O. Box 180, Jefferson City, MO 65102.

See also ***Meetings of Interest*** *in previous issues of* ***Park Science.***

Parks Need To Gear Up For 'Can't Happen Here' Crises

By Cat Hawkins

Many of the units of the National Park System are adept at playing "what if" games, and it is fortunate that they are. These parks answer "what if" questions with emergency response plans: "what if" a climber fails to report?, "what if" a hurricane warning is posted? Search and rescue plans, hurricane contingency plans, etc., are products of the "what if" games, and they serve well to guide actions during emergencies.

Facing many, if not *most* parks today is a potential emergency for which few have played the game. EPA is aware of the potential however, as this agency initiated a program called L.U.S.T. (now shortened to U.S.T.), an acronym for Leaking Underground Storage Tanks. Under this program, agencies are required to inventory all underground fuel storage tanks. Remaining ignorant of and unresponsive to warning signs of leaking fuel storage tanks may bring effects as long lasting as those caused by any hurricane.

Mount Rainier National Park experienced just such as emergency this past summer, and learned that shooting from the hip is no substitute for a practiced aim. During Spring 1985, park visitors reported smelling oil at two locations. In early July 1985, as snow relinquished its winter-long hold on Paradise, the fuel oil smell mystery was solved. Just below the Paradise Visitor's Center, at the 5400′ elevation, an acre of alpine meadow lay covered with oil leaked from an underground fuel storage tank.

Through this event, Mount Rainier's staff became aware of shortcomings and ignorance within park operations that delayed report of the spill and actions to manage the site. The event is generic; it could happen in any park. Similarly, shortcomings in dealing with the situation are not unique to Mount Rainier. Although experience is a wise teacher, learning need not occur the hard way. This article describes aspects common to many parks and actions they might take to direct the "what if" game of planning.

In 1967, three 10,000 gallon underground fuel storage tanks were installed to supply the newly-constructed Paradise Visitor Center. Since then, records of fuel consumption were kept by Rainier's maintenance division only to indicate when reordering fuel was required.

Shortcoming No. 1: The record established for reordering fuel was inadequate as a tank monitoring scheme. The three 10,000 gallon tanks were interconnected when installed so fuel could be moved between tanks. Because fuel was moved from tank to tank, and fuel levels checked infrequently (only as needed to determine reorder time), the leak went undetected.

On June 10, 1985, visitors entering Rainier's Hiker Information Center reported smells of fuel oil from Narada Falls, two miles downstream from Paradise. One visitor complained that the picnic area near Paradise "smelled like a service station." Clues to the mystery of "where did it go?" were beginning to accumulate, yet these reports were not compiled, since they were made to different personnel at different times.

Shortcoming #2: Again, word that there might be something wrong failed to proceed far up division

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Aerial view of Paradise Meadow *shows parking area at far left, oil draining in at top left-of-center, and oil draining out at right just below center (into Paradise River). The white patches are some of the several thousand absorbent pads used to soak up oil. Dark areas are dead or dying vegetation.*

Hazard Headache At Padre Island

Editor's Note: Another hazardous waste problem – one with a slightly different twist – surfaced at Padre Island National Seashore in 1985. Superintendent Lukens reports on an ongoing problem with 30- and 55-gallon drums washing ashore, especially near Big Shell Beach, within the park.

By William M. Lukens, Superintendent
Padre Island National Seashore

It has been well documented that Gulf currents move both surface and subsurface debris toward Padre Island with north-south convergence at 27°N 97°S. No other area in the Gulf of Mexico experiences this situation on such a broad scale.

The drums pose a hazard based on the following information:

1. Labeling on some drums indicate that hazardous substances had been contained therein at one time and might still be present;
2. Probable sources for the drums (OCS platforms, crew boats, cargo ships, etc.) are known to carry or use hazardous materials; and
3. Some drums have distorted shapes, indicating a reaction inside.

NPS concern for the visitor and the environment was supported by the following observations:

1. Substances were noted leaking into the beach sand from damaged and rusted drums;
2. Bullet holes in drums indicated visitors had been using them for target practice and substances had leaked from the bullet holes; and
3. Drums were being used by visitors as wind breaks and campfire reflectors.

A plan for regularly removing the drums was devised for the heavy-use public areas, and a less frequent, periodic removal schedule was set up for the low-use (4-wheel drive) area. It was not until 1981, when the plan was implemented, that the magnitude of the problem became apparent.

In 1981, the park recovered 170 55-gallon drums within a distance of 60 miles at a cost of about $10,000. In August 1982, 40 drums were counted on the 10-mile, 4-wheel drive stretch of beach; in August 1983, 60 drums; in April 1984, 80 drums – all on the same beach stretch. In '83 and '84 the park recovered and stored 26 drums containing substances from the same 10-mile stretch. Funds for this action came from the park's operating accounts.

Under 16 USC 1, the NPS is mandated the responsibility for visitor safety and health within designated park boundaries. A drum containing hazardous substances may be viewed as analogous to a bear coming into a park campground. The NPS has both a legal and a moral responsibility to remove such hazards "in a timely manner."

The Clean Water Act aspects of the Padre Island situation are much the same as that of Mount Rainier, except that oil is considered "non-hazardous" at Padre Island but not so at Mount Rainier. And whereas the Mount Rainier situation is a one-time occurrence with little chance of affecting visitor safety, the Padre Island problem is on-going, with results that at any time could range from non-hazardous to lethal.

In compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and with the Regional Contingency Plan, the Marine Safety Officer, US Coast Guard, Corpus

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Parks Need To Gear Up

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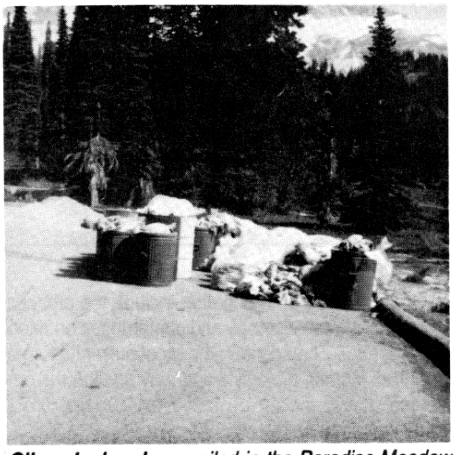
lines. A huge oversight? Not really, for although melt-out was progressing quickly, Paradise still remained covered with several feet of snow. Followup of visitors' reports verified a smell of fuel, but the odor was diffuse and its source still well hidden. As for Narada Falls, the oil likely passed this point quickly, for very little odor lingered. Visitor reports remained a curiosity, but personnel who investigated saw no need to raise the red flag.

By June's end, the last few feet of snow rapidly disappeared from Paradise and the smell of oil was strong. July 3 finally saw the meadow revealed, almost an acre covered with oil. During the previous winter, leaking fuel oil from one of the 10,000 gallon tanks had traveled downhill through soils disturbed in building the Paradise road and flowed into the snowpack on the meadow below. The problem – oil in the meadow – was now evident, but procedures for its management were unclear.

Shortcoming #3: Park personnel were unprepared for an event of this type and knew only vaguely how to respond. After all, who would expect an oil spill at Mount Rainier? (Could this be *your* park?)

The "learn as you go" approach to management of the site was as successful in outcome as any might have been by this stage of the spill. However, the process was far more confusing and time consuming than if it had followed a thoroughly researched contingency plan. Through a maze of phone calls, involving the Pacific Northwest Regional Office, Regional Environmental Officer for the Department of the Interior (Office of the Secretary) Charles Polityka, EPA, USGS, local water analysis labs, local environmental cleanup companies, etc., mop up of the site and water sampling began.



***Oil-soaked pads** are piled in the Paradise Meadow parking area, awaiting disposal by truck.*

In retrospect, the process seems uncomplicated, but at the time, never having dealt with or imagined such an event, park managers were bewildered. However, an image of the event's management as "well-intentioned but without direction" would be incorrect. Involved personnel notified appropriate authorities, outlined objectives and alternatives for site cleanup, and kept voluminous records of daily events. Bill Longston, of the EPA Environmental Emergency Response Team, noted that in none of his experience dealing with spills had he ever found one so well documented.

In generating alternatives for management of the site, Rainier's natural resource planning staff first looked to EPA for clearcut, step-by-step answers to

***Doing their thing**, these white "diapers" sop up spilled oil without absorbing water in Paradise Meadow.*

what should be done about cleaning up the site. The staff was given only one definite response: that the park was required to monitor waters draining the meadow and demonstrate decline of oil and grease amounts as cleanup of the spill progressed.

EPA initially demanded excavation and removal of contaminated soil to a hazardous waste disposal site. However, Longston noted that EPA "took the position to back off our normal aggressive approach" since Mount Rainier is a federal, not private, facility, and as pointed out by Park Supt. Neal Guse, "The Park Service has its own mandate, which differs considerably from any other agency's or private concern's. We have a responsibility to clean up an emergency spill without doing more damage in cleanup than was done by the original accident."

This formed the objective for management of the site, as cleanup operations proceeded. For safety, the site was restricted to visitors as hundreds of "diapers," designed to absorb oil but not water, were acquired from a Seattle environmental cleanup company and applied to wet areas of the meadow. The scene seemed misplaced, as staff members wearing disposable white paper "moon suits," rubber boots, and gloves wandered about the oil soaked alpine meadow. Two absorbent booms were placed across the creek draining the meadow, and two sandbag dams installed with underflow pipes to allow surface pooling and absorption of oil. Water sampling within the site, in unaffected areas, and downstream of the spill for approximately two miles began immediately. Sampling continued weekly the following three weeks and twice per month thereafter. Photopoints were established during cleanup, and a park botanist began monitoring vegetation damage and recovery.

The suspected tank was pumped dry and tested, and a leak detected, though its nature or position could not be determined. The specific cause of the leak may be related to design, structure, or geology. No test could produce a conclusive answer, but gradual deterioration of the tanks of this "vintage" is to be expected. All three 10,000 gallon tanks at Paradise are scheduled for replacement, with the first new tank to be installed this year. New tanks will be double walled, made according to Steel Tank Institute specifications. In addition to testing the tanks, EPA required drilling to determine if oil remained pooled beneath the leaking tank. Small amount of oil were found, though not in quantities substantial enough to require excavation.

Prior to winter's claim of the meadow in 1985, the spill site was made ready for a similar event this spring. It is quite possible that melt waters may purge oil remaining in the meadow's soil causing watershed contamination once more. Clean containment booms were placed across the stream and sandbag dams fitted with additional underflow pipes to accommodate spring's meltwater torrent. The snowpack is now being monitored along transects in suspected areas of leakage or potential oil pooling. Also, a daily monitoring program to establish accurate records of contents in

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Hazard Headache

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Christi, Texas, was designated On-Scene Coordinator (OSC).

Current data indicate that approximately 150 drums per year (one every two days) come ashore on 66 miles of park beach. Of these, 30 to 50 percent contain substances. Drums are in various stages of deterioration from almost new to rusted through.

Analysis of drums indicated they contain such substances as: trichloroethene, xylene, quinoline, flammable liquids, heavy metals exceeding minimum levels for As, Ba, Cd, Cr, Pb, Se, Ag. No PCBs or pesticides above minimum levels were detected.

Because of heavy visitor use, drum removal from North, South, or Closed Beach should take place within two hours of discovery. Where public use is lighter, drum removal should take place twice monthly. Delayed removal increases container deterioration and potential for leakage or rupture.

All drums whether empty or not must be removed. Otherwise, any drum left must continue to be treated as suspect. All drums whether empty or not require minimum Level B personal protection for handling and Level C protection for upwind approach for identification and recording (non-handling).

All drums presently in the holding area have been sampled and analyzed and will be removed as soon as a permitted facility can be located. Such a facility willing to accept the materials has not been found to date. The OSC continues to search.

This article was condensed from a Report, complete with tables and figures, dated July 25, 1985, and available from Lukens at Padre Island NS, 9405 S. Padre Island Dr., Corpus Christi, TX 78418.

Meanwhile, as of Dec. 31, 1985, 450 drums constituted one full year's accumulation, collected on the Padre Island NS shores. Of these, one-fourth contained substances that met criteria for hazardous wastes and have been shipped to the nearest approved disposal site – in South Carolina. The nonhazardous substance containers were disposed of at approved sites within the Region.

Cost of the disposal effort for calendar year 1985 was half a million dollars, according to Superintendent Lukens. The NPS contributed $65,000; EPA's Superfund provided $350,000; the remainder came from monies available under the Clean Water Act. National attention was called to the overall problem by Cable News Network in an hour-long special, "Crisis in Our Oceans," of which approximately 8 minutes was devoted to Padre Island NS.

Problem Exotic Plants in Midwest Regional Parks

By Karen Pestana

The invasion and persistence of exotic plants is a major management problem in most national parks of the Midwest Region. All but a few parks are attempting some method of exotic plant management, but little is known on the effectiveness of these methods. In an effort to understand this problem, exotic plants from 19 of the 30 Midwest Region parks were identified from the parks' flora checklists, and management techniques were sought for control of the most pervasive and troublesome species.

I surveyed the most current checklists for each park and identified all exotic species, using published floras. Data on each exotic species were recorded in a computerized base that included scientific name, common name, place of origin, the park(s) in which it occurred, and synonyms.

A final list of the most troublesome species was developed by considering the most pervasive exotics (those occurring in 10 or more parks), a list of those causing major problems in natural areas (from the participants in the Tenth Midwest Natural Areas Workshop held October 1983 in Kentucky), and responses to a telephone survey of each park in May 1985.

At least 630 exotic species occur in 19 Midwest Region parks. The percentage of exotics for each park ranges from 36 at Mound City Group National Monument in Ohio to 7 at Voyageurs NP in Minnesota. However, these figures are only estimates of the exotic to native proportion in each park, as some checklists are more complete than others.

The most troublesome exotics are divided into two categories (Table 1). The first group includes those exotics that occur in 10 or more parks and were identified at the 1985 Kentucky Workshop as exotics causing major problems in natural areas. Bull thistle was also included, since management personnel from four parks feel it is threatening native plant communities.

The second group includes exotic plants not as pervasive in the Midwest Region parks, but indicated by park management as troublesome exotics in parks where they occur. All but one of these, field bindweed, were also listed as major pests at the Kentucky Workshop. The parks listed after each species have reported that the exotic plant is highly invasive, destroys the natural scene, or is in some other way a major management concern.

I asked park managers to identify which of their exotic plants currently are being managed and if so, by what method. The most common method is use of herbicides, followed by cutting or mowing and prescribed burning. The least practiced methods are manual removal and biological control. Manual removal is used primarily when the plants are limited to a small area; biological methods are not currently practiced in Midwest Region parks. Scotts Bluff National Monument in Nebraska plans to initiate a program in 1986 or 1987 for the control of Canada and musk thistles by introducing herbivorous insects, and Indiana Dunes National Lakeshore is experimenting with cattail competition to control purple loosestrife.

After an extensive literature search and conversations with personnel from the Illinois Department of Conservation, The Kentucky Preserve Commission, and the Midwest Regional Office of the Nature Conservancy, a bibliography of references on exotic plant management and control was compiled. The bibliography includes articles from scientific journals, university publications, and state and national nature preserve organizations.

The literature search identified good, up-to-date control and management methods for thistles, Japanese honeysuckle, multiflora rose, leafy spurge, and field bindweed. Limited information is available for the management of other species in natural areas, although a wealth of information may exist for their control in agricultural settings (usually inappropriate for nature preserves).

Studies on control and management of exotic plants are continually updated and information on the latest advances are frequently published in the *Natural Areas Journal, Restoration and Management Notes,* and the *National Park Service Integrated Pest Management Information Manual.* The Midwest Regional Office of the Nature Conservancy has updated computer printouts on control and management of some exotic plants.

Other sources of information include the proceedings of special workshops and conferences on exotic plant control. They contain the most current information from leading biologists and may provide the only source of information on some exotics that are in early stages of study.

The bibliography of references and list of exotic plants in the Midwest Region parks has been published as Research/Resources Management report MWR-6, "*Problem Exotic Plants in Selected Parks of the Midwest Region and a Bibliography on their Management.*" The report was presented at a 1985 Midwest Region resource management workshop at Indiana Dunes National Lakeshore. The workshop provided an overview of the exotic and pest plant situation in the Midwest Region parks and included specific information on control methods and monitoring techniques.

Copies of the report are available from the Chief Scientist, Midwest Region.

Pestana is a cooperative education student on the Midwest Region staff.

Table 1. The most pervasive and troublesome exotic plant species in Midwest Region park units.

SPECIES	COMMON NAME	# PARKS	AREA OF CONCERN
1) EXOTIC SPECIES OCCURRING IN 10 OR MORE PARKS:			
Bromus inermis	smooth brome	10*	HOME
Cirsium arvense	Canada thistle	10*	CUVA; PIPE; SCBL
Cirsium vulgare	bull thistle	11	CUVA; GWCA; PIRO; WICR
Melilotus alba	white sweet clover	16*	PIPE
Melilotus officinalis	yellow sweet clover	15*	PIPE
Poa compressa	Canada bluegrass	10*	GWCA
Verbascum thapsus	common mullein	15*	HOME
2) OTHER PROBLEM EXOTICS			
Carduus nutans	musk thistle	4*	HOME;SCBL;WICR
Convolvulus arvensis	field bindweed	9	GWCA;SCBL
Daucus carota	Queen Anne's lace	9*	GWCA
Euphorbia esula	leafy spurge	2*	PIPE
Lonicera japonica	Japanese honeysuckle	4*	MOCI
Lythrum salicaria	purple loosestrife	2*	INDU
Rosa multiflora	multiflora rose	6*	GWCA/INDU
Vinca minor	common periwinkle	6*	PIRO

Park Code Definitions:
CUVA – Cuyahoga Valley National Recreation Area, Ohio
GWCA – George Washington Carver National Monument, Missouri
HOME – Homestead National Monument of America, Nebraska
INDU – Indiana Dunes National Lakeshore, Indiana
MOCI – Mound City Group National Monument, Ohio
PIPE – Pipestone National Monument, Minnesota
PIRO – Pictured Rocks National Lakeshore, Michigan
SCBL – Scotts Bluff National Monument, Nebraska
WICR – Wilson's Creek National Battlefield, Missouri

*Major pest species identified by the participants in the Tenth Midwest Natural Areas Workshop held in October 1983.

Parks Need To Gear Up

Continued from page 21

the other tanks is underway.

Rainier's natural resource planning team has prepared an emergency response plan with guidelines for actions to follow a spill. Legislation pertinent to spill emergencies are RCRA – Resource Conservation and Recovery Act of 1976 – and CERCLA – Comprehensive Environmental Response Compensation and Liability Act of 1980. RCRA amends the Solid Waste Disposal Act and regulates, among other things, management of hazardous wastes. Depending upon quantities involved, disposal of cleanup materials from a spill may be governed by this act as well. RCRA and CERCLA both provide for strict liability of ALL involved persons, including the federal government; RCRA specifically waives "sovereign immunity."

Applicable Interior documents are the Departmental Manual, Park 110, DM 22.1 Office of the Secretary, Chapter 22.1, Office of the Environmental Project Review; Part 296, DM 2.1, Chapter 2, Oil Spill and Hazardous Waste Releases; Part 910, DM 4.0, Interior Emergency Operations, National Oil and Hazardous Substance Contingency Plan. Specifically, "the bureau" (NPS in this case) is responsible for immediate notification of the National Response Center and may be criminally liable for failure to report oil spills or hazardous waste problems.

Following notification of the National Response Center (800-424-8802), containment of a spill, then emergency cleanup, are priority procedures. Contractors available for cleanup and cleanup materials are listed in Rainier's plan, as are instructions to train park staff in advance on how to deal with hazardous waste spills. Following recommendation from Interior's Environmental Officer Polityka, the plan calls for communication with the Regional Director during spill cleanup almost hourly, not merely once or twice a day. Polityka suggested that the Regional Office have primary and alternate representatives to aid on-site coordination and decision making. A daily status report should be prepared to include 1) action of the day, 2) action for tomorrow, 3) names of cleanup workers, hours they worked, personal protective equipment used, any contacts with the chemical, any medical emergencies, etc., 4) equipment used and money spent.

If relevant, water sampling should be done following approved methods for sample collection and analysis. During transport of samples to a lab for analysis, a "custody procedure" and signature log should be maintained. Photopoints should be established and monitoring begun to assess damage and recovery to flora and fauna associated with the spill. Available literature should be consulted for studies following spills in similar areas. Finally, the subject should be used as interpretive material to educate visitors, even *before* a spill occurs to prompt their attention.

That an oil spill occurred in an alpine meadow at Mount Rainier shows that it can happen anywhere. Park staff were forced to handle the event without benefit of having played the "what if" game. Hindsight is 20-20; other parks can learn from the experience of Mount Rainier to 1) develop inventories and monitoring procedures for fuel storage tanks, and, 2) develop emergency response plans for oil spills in their area. Fuel storage tanks do not last indefinitely; spills can happen and *will happen.*

Hawkins is an NPS Natural Resource Specialist trainee, currently assigned to Mount Rainier NP.

Biological Diversity Workshop Considers NPS Conservation Role

Some 30 scientists and conservationists, largely from outside the National Park Service, gathered in Washington, D.C., March 17-20, to consider the Park Service's proper role in the conservation of biological diversity and education of the public about the importance of national parks in preserving gene pools.

NPS Director William Penn Mott, Jr., had asked the Park Service to assume a leadership role and approved funding for a workshop that would recommend ways to achieve these two objectives. Last December, Christine Schonewald-Cox, NPS scientist at the University of California-Davis CPSU and organizer of the workshop, convened a 10-member planning committee to help structure the agenda.

Following the workshop, this same committee will formulate the recommendations, which will be presented to the Director by summer. A report on the workshop findings will appear in a later issue of *Park Science.*

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Conference postponed:
to be rescheduled.
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Endangered Plant Conference Calls For Papers

The California Native Plant Society (CNPS) will serve as lead sponsor for a conference on the conservation and management of rare and endangered plants Nov. 5-8, 1986 in Sacramento, Calif. Persons wishing to present papers are invited to submit an abstract.

Papers describing research on endangered plants are requested. Taxonomic and ecological studies are of interest although emphasis will be placed on management-related topics including specialized field techniques for evaluating, monitoring, and mitigating adverse effects on endangered plants. Experience from regions other than western United States are welcome. Proceedings will be published by CNPS.

Abstracts are due by June 1. Abstracts and requests for information should be directed to Jim Nelson, Conference Coordinator, California Native Plant Society, 909 Twelfth Street, Suite 116, Sacramento, CA 95814.

Resource Management Courses

Two courses in resource management will be offered this summer by the Rocky Mountain Research Station of the University of Colorado. American Wildland Management, an intensive survey of ecologic and economic principles related to wilderness management, takes place in both the Colorado Front Range and the Grand Teton-Yellowstone area. Tropical Mountain Ecology and Resource Management in Hawaii, encompassing the impact of exotic flora and fauna on native ecosystems and management of endangered species, will be conducted on the islands of Hawaii and Maui. Information on these and other summer and winter courses may be had from Dr. Mark Noble, Mountain Research Station, Institute of Arctic and Alpine Researcch, U of Col., Nederland, CO 80466, or phone (303) 492-8841.

George Wright Society Elects New Officers

The George Wright Society's triennial election has produced the following officers for the next three-year period: President, Christine Schonewald-Cox; vice-president, Gary Larson; treasurer, Lloyd Loope; secretary, Naomi Hunt; directors, Clay E. Peters, John G. Dennis, Edwin C. Bearss, and Roland H. Wauer.

Broadened Role For Interpretation To Be Examined

An NPS task force organization meeting to respond to Director Mott's call for "extension of the interpretation mission" of national parks, met in New York City Feb. 6 at the call of Dr. Theodore W. Sudia, who now holds the office of National Park Service Senior Scientist.

Organizers included Bruce McHenry, interpretation chief for the North Atlantic Region, Sam Holmes, chief of interpretation for Gateway NRA, and John Tanacredi, natural resource management specialist at Gateway. Tanacredi is Gateway's contact and coordinator for research within the parks by local and regional researchers. Holmes works with New York area schools and neighborhood organizations in using Gateway's resources for both formal and informal educational purposes.

The committee began with a recognition of the institutional nature of the National Park Service and the NPS responsibilty for outreach to other institutions – the media, universities, organizations, clubs, neighborhoods, etc. – in an active effort to make park resources available for the purposes the System was established to serve.

The group agreed to appoint an interpretation task force that will represent the System as a whole, to put together a Report to the Director on how best to proceed in upgrading in-park interpretation and cooperation with other "user" institutions.

Biogeochemical Cycling Workshop

From Bob Stottlemyer at the NPS Great Lakes Area Resource Studies Unit comes word his workshop on "The Importance of Biogeochemical Cycling Research in Preserving National Park Ecosystems," to be held at the 1986 ESA/INTECOL meeting in Syracuse, NY, Aug. 10-16, 1986. The meeting title is "The Fourth International Congress of Ecology," and was organized principally by the International Association for Ecology (INTECOL) and the Ecological Society of America (ESA). Frank Golley is chairman of the program committee.

Stottlemyer's workshop objectives are (1) to examine how the ecosystem approach might provide earlier indications of change attributable to man, (2) to consider how holistic study, through identification of ecosystem interactions, might provide a better assessment of impact magnitude, (3) to evaluate how ecosystem approach permits better projection of future effects under varying scenarios, and (4) to present results from ongoing ecosystem-level research in national parks.

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In the Next Issue:

A story and pictures of the new Center for Urban Ecology in Washington D.C.; "Prescribed Fire: Is It an Option for Coastal Barrier Management?" by Susan P. Bratton; "Dune Restoration at Fort Matanzas National Monument" by Brian Peters; "A Smoke Management Study for Grand Canyon" by Joe Boatman and Donald Henderson; "Vegetation Management in National Parks in Arid Areas of the Pacific Northwest" by Jim Romo and William Kreuger; "The Boundary Approach: A Geographic Analysis of Design and Conservation of Nature Reserves," by Christine Schonewald-Cox and Jonathan Bayless, three book reviews, and MAB Notes.

The Washington office is increasing its effort to improve communication among NPS people involved with acid rain and other forms of chemical pollution. Two signs of this will appear in the summer issue of *Park Science*: 1) a detachable supplement summarizing recent research and events in these fields; and 2) a form to be filled out by anyone interested in obtaining computerized information on various aspects of atmospheric pollution research; this will also help WASO build a directory of people working on chemical pollution.

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